Art54 Description**

Art56 Description

In a further refinement, multiple Artcams as previously described are interconnected via their USB ports so as to provide a cascading of imaging effects. Through suitable programming of the internal computer portions of each Artcam, a cascading of imaging effects can be achieved.

The preferred arrangement is as illustrated in Fig. 315 wherein a series of Artcams, e.g. 6802, 6803, 6804, are interconnected 6805 via their USB ports. Each Artcam 6802, 6803, 6804 is provided with a corresponding Artcard 6807, 6808, 6809 having a suitable image manipulation program stored thereon. Further, the instructions for utilization in a network environment can be provided on the Artcard 6807, 6808, 6809. The image 6810 sensed by the Artcam 6802 is then manipulated by the manipulation program on Artcard 6807 with the result being forwarded 6805 to Artcam device 6803 which applies the image manipulation function provided on Artcard 6808 producing a corresponding output which is forwarded to the next Artcam in the series. The chained Artcam has been modified so as to have two USB ports for this purpose. The final Artcam 6804 applies its Artcard manipulation stored on Artcard 6809 for producing output 6812 which is a conglomeration of each of the previous image manipulations.

The arrangement 6801 on Fig. 315 thereby provides the opportunity to apply multiple effects to a single sensed image. Of course, a number of further refinements are possible. For example, each Artcam could print out its own manipulated image in addition to forwarding the image to the next Artcam in the series. Additionally, splitting of paths where one Artcam outputs to two different downstream Artcams which result in different final images being output could also be provided. Additionally, loops, etc., could be utilized.

Art57 Description

In a further refinement, the technologies as disclosed are adapted to be incorporated into a set of binocular glasses such that images can be printed out on demand by a user of the binocular glasses. Turning initially to Fig. 316, there is illustrated an example of the binocular glasses system. The glasses 6901 can be of a known type having been modified in accordance with the principles of the present invention. The glasses can include the usual optical lensing systems having lensing inputs 6902, 6903. The two lensing systems being mounted to a connector plate 6906 via hinging systems 6904, 6905. The arrangement being substantially conventional.

The first optical system 6902 includes a beam splitter device 6908 which splits the optical path 6909 of light entering the optical system 6902 into two paths 6910, 6911. A first path 6910 is projected onto a side mounted CCD system 6914. The second optical path 6911 continues out to the eye piece 6915. The beam splitter 6908 results in an attenuation of the output intensity of ray 6911. Therefore, a corresponding attenuation filter 6918 can be also provided so as to match the attenuation of the beam splitter 6908 within the optical system 6903.

The CCD imaging device 6914 therefore images the same scene which is viewed by the optical system 6902. The CCD device 6914 is interconnected to a processing system mounted on printed circuit board 6920 which can contain an Artcam central processor and memory devices. The Artcam central processor device includes significant image processing capabilities and operates to control the CCD device so as to capture an image and print out the image utilizing a print head mechanism 6923, the printer utilizing an ink jet printing device so as to eject ink on to print media which can comprise a "paper" film (really a suitable polymer) which is supplied

from a detachable disposable print roll 6925 which includes printing media and printing inks. The print roll 6925 is encased within housing 6926 which also includes a detachable battery 6927 located within a suitable housing.

Upon a user depressing a button 6919, the Artcam central processing device activates the CCD 6914 to capture the imaged scene. The image captured by the CCD device 6914 is processed by the ACP processor and forwarded to print head 6923 for immediate printing out so as to provide an immediate permanent record of the imaged scene. The print head again being as previously described.

A number of modifications can be carried out to a further refinement. For example, a USB port could be provided, interconnected to the Artcam central processor such that image processing algorithms can be preloaded down to the binoculars 6901 and a series of buttons provided for the activation of the routines. The routines can include various image enhancement operations etc. Additionally, the output image could be modified in many different ways so as to enhance features of the image. The image could be further enhanced by the placing of associated information such as the time of day and location automatically on the image. Additionally, the binoculars could be interconnected to a global positioning system (GPS) such that the coordinates of the observer are also printed immediately on the output image. Additionally, other options such as providing range finding facilities for locating of objects and displaying information related to the located objects on the output image could be provided.

Art58 Description**

Art59 Description

In a further refinement, the technologies as disclosed are utilized to provide fault tolerant data arrays on a card surface with each new data array being updated by means of rewriting the data in another fault tolerant array.

Turning initially to Fig. 317, there is shown a card 7101 after it has been fully utilized in the writing of data arrays, eg. 7102 written on the surface thereof. Each of the data arrays, eg. 7102 can encode approximately 20 KB of information with an array of 64 data blocks to been shown on the surface of card 7101. Of course, other arrangements are possible having either less or greater amounts of data written within each data block, eg. 7102. Initially, the card 7101 has no data blocks written on it. Alternatively, perhaps a single utilization data block is written on the surface of the card.

Turning now to Fig. 318, there is illustrated a second card 7105 which has been "updated" twelve times with a current data block 7106 being the final data block written. Hence, each card, eg. 7105 is utilized a number of times such that it can be updated in accordance with the number of data blocks provided in the fully determined format of the card 7105.

Turning now to Fig. 319, there is illustrated the structure of a single data block, eg. 7108 which can comprise a scale down version of the "Artcam" technology. The data block 7108 consists of a data area 7109 which contains an array of printed dots having a one pixel wide border in addition to a series of clock marks along the border (not shown). Along the edges of the data area 7109 are targets 7110 which are provided so as to assist in locating and reading the data area 7109. The structure of each target 7110 can be as illustrated in Fig. 320 with a large black area surrounding a single white dot. Of course, other structure formats may be possible. The targets 7110 are provided so as to accurately locate the data area 7109. The targets 7110 are further provided so that they may be accurately sensed and accurate position information derived.

Turning now to Fig. 321, there is illustrated a card reading and writing apparatus 7120 with Fig. 322 showing an enlargement of the essential parts of Fig. 321. The apparatus 7120 includes a slot 7121 for the insertion of a card 7122 on which is to be printed information. A number of pinch rollers, eg. 7123, 7124 control the movement of the card across a printhead 7125 and a linear CCD scanner 7126. The scanner 7126 is responsible for scanning the data passing underneath it. In Fig. 322, there is illustrated an enlarged view of the arrangement of the printhead 7125 and CCD scanner 7126 with respect to the inserted card 7122.

Turning now to Fig. 323, there is illustrated schematically the arrangement for insertion of the card 7122 into the CCD reader such that the CCD reader operates to forward the card 7122 past the CCD reader 7126 so that the information stored on the card 7122 can be decoded by an Artcam central processor unit attached to the CCD reader 7126. When it is desired to eject the card 7122 from the card reader, a determination is made whether it is necessary to write a new block to the card. The new block's location will be known from the previously scanned CCD data. The ejection of the card is begun as illustrated in Fig. 324 moving the card across printhead 7125 and CCD scanner 7126. The scanner 7126 monitors a current location of the card 7122 and in turn causes the printhead 7125 to eject drops when required as illustrated in Fig. 325 wherein the square 7128 is updated with the new data. The card is then ejected from the card reading/writing apparatus (Fig. 321) in the normal manner similar to that of a floppy disc or the like. The card can then continue to be utilized until all the data spaces are filled out in which case a new card can be produced.

It will be therefore evident that the utilization of the foregoing card system provides for an effective and inexpensive form for the distribution of information in that the cards can be inexpensively produced and utilized in a flexible manner to distribute information.

Turning now to Fig. 326, there is illustrated a schematic functional block diagram of the different functional blocks utilized in the Artcard reader. The printhead 7125 and the linear CCD 7126 operate under the control of a suitably programmed Artcam central processor chip 7130. The ACP 7130 includes associated memory 7131 for the storage of scanned data and other data and programs. The ACP further includes facilities for motor control activation of various motors 7132 utilized in the operation of the pinch rollers. Of course, other control buttons, etc. can be provided in accordance with requirements. The utilization of such an arrangement provides for a system which allows for the ready monitoring and updating of information stored on a cards surface.

<u>Art60 Description</u>

In a further refinement, an Artcard photo and vending machine is provided which enables a user to construct their own Artcard on demand. The vending machine can be constructed in a similar manner to the usual photo vending machines however, this is not essential with the only requirement being significant computational resources provided for the creation of automatic Artcards within a given time.

Turning initially to Fig. 327, there is illustrated schematically the functional components of a further refinement 7201. A further refinement 7201 can include a high resolution scanner 7202 for the scanning in of a user's example photo 7203. The scanner 7202 is again optional and allows users to manipulate their own photos to provide an added degree of realism to the Artcard production system. The photo 7203 scanned by scanner 7202 is forwarded to the core computer system 7204 which can comprise a high end PC type computer with a suitable operating system and programs. The computer 7204 is responsible for storage of the scanned photos and for the

control of a photo printer and Artcard printer 7205. The photo printer and Artcard printer 7205 is preferably able to print on both sides of an output print media and can utilize printing technologies as previously disclosed. The printer 7205 outputs a manipulated version of user's photo 7206 in addition to a corresponding Artcard 7207 (being printed on both surfaces) which contains encoded instructions for the image processing manipulation of the photo 7203 in order to produce the photo 7206. The encoded instructions being output in an Artcard format.

The computer system 7204 also includes a user interface 7209 which can be of a standard touch screen type user interface. The computer system also controls or incorporates a payment system 7210 which can comprise a standard coin or note payment system or could also comprise a credit card payment system with appropriate network connections to a credit card service provider for authorisation of transactions. Additionally, EFTPOS facilities might be provided.

A user inserts their photo 7203 in a scanner slot 7202 and the photo is scanned stored and subsequently ejected. Subsequently, the user interrogates the user interface 7209 which can be located inside the "photo booth". The user interface 7209 can contain instructions initially for entry of money in the payment system 7210. However, the core of the user interface 7209 is in the creation of a wide range of Artcards by means of the touch screen facility.

An example of a suitable user interface is that depicted in Fig. 328. The core user interface can consist of presenting a user with a large number of sample thumbnail images 7213 which have been manipulated in accordance with methods which will be discussed hereinafter. Initially, the image manipulation 7213 may be divided by subject areas, for example, corporate, birthdays, seasonal events, types of manipulations etc. The user is instructed to choose by means of the touch sensitive screen a particular image, e.g. 7213 which they like. If no such image exists, the user can choose a arrow button 7214 which provides a further array of manipulations on a current level. When the user chooses an image 7213, this image is utilized in the production of further alternatives which have a similar "theme" to the chosen image and present a series of alternative manipulations. The user is able to then continue choosing images from the selected variations.

Desirable images can be saved using a save button 7217 and the user interface provides for the viewing of saved choices 7218 along side the current array. Navigation buttons 7215 and 7216 provide for alternative forms of navigation with the button 7215 going back to a previous screen and the button 7216 returning the user to a higher level. In this way, the user is able to navigate through a wide range of Artcards so as to produce their own particular customised requirements. In this way, unique artistic creative endeavours can be encouraged for the production of unique Artcards.

The production of such a wide range of Artcards relies upon the utilization of genetic algorithm techniques to provide the user with the role of the creator in the production process. Turning now to Fig. 329, there is illustrated an example of the software layout of the application running on the computer system of Fig. 327. The software layout 7220 includes a genetic pool 7221 of possible image manipulations and theme manipulations which can be applied to a particular image. This genetic pool is utilized by a genetic algorithm core 7222 for the creation of new species. For an introduction to the field of genetic algorithms standard text, e.g. "Genetic Algorithms" by Golberg, in addition to the latest proceedings in this field. Alternatively, the field of genetic programming could be utilized and, in this respect, reference to the standard works by Koza entitled "Genetic Programming".

The genetic algorithm core can also utilize the users' choices 7223 in the creation of new suitable images. The output of the genetic algorithm core can comprise suitable proposed new images which are then forwarded to a user interface module 7225 for display on the touch screen display.

Returning again to Fig. 328, once a user has found a desirable selection, an accept button 7219 can be activated which results in the user payment being required and accepted and which in turn results in the computer system 7204 (Fig. 327) instructing the printer 7205 to output the image 7206 in addition to the series of image manipulations on the Artcard 7207 for utilization by a user in other devices which accept Artcards 7207 (for example, the aforementioned Artcam devices).

It would therefore be readily evident to the person skilled in the art that a further refinement provides for a system for creating complex personalised customisable images which can then be independently utilized by users. The utilization of multiple images results in a significant combinatorial explosion of possible Artcards which can in turn lead to a significant personalisation.

Of course, many other types of core techniques could be utilized in the construction of the images. For example, other non-genetic techniques may be suitable. In a worst case, each image choice could be manually prepared. Further other suer interface facilities could be provided. Additionally, the present invention can be implemented in a non vending machine environment such as on a standard computer system.

The operation of a further refinement allows for the significant expression of personal creativity and, it is envisaged, that individual creations by Artists may themselves take on a significant value in providing an Artcard "series" of a individual artist etc.

<u>Art61 Description**</u>

<u>Art62 Description</u>

The basics of the aforementioned Artcam arrangement are indicated in schematic form 7401 in Fig. 330. The arrangement includes a CCD sensor 7402 for sensing an image or scene. Additionally, an Artcard reader sensor 7403 is provided for sensing the reading of an Artcard 7408 upon which is encoded image manipulation algorithms for manipulation for the sensed image. Both the CCD sensor 7402 and Artcard reader 7403 are interconnected to an Artcard central processing unit (ACP) 7404 which provides complex computational power for manipulation of the sensed image. Additionally, a memory unit 7405 is provided for the storage of images, sensed data, programs etc. Interconnected to the ACP 7404 is a print head 7406 for the printing out of final photos 7407 on print media supplied from an internal print roll.

In a further refinements, a unique series of Artcards 7408 are provided for insertion into Artcard reader 7403 for the unique modified control of the Artcam central processor 7404. A first example is as illustrated with reference to Figs. X2 and Fig. 332 and provides for the utilization of multiple Artcards so as to provide overlapping or multiplicative image effects. A suitable replicative Artcard is as illustrated 7410 in Fig. 332 which contains on one surface thereof instructions on how to operate the camera device so as to cause the effects to be combined. The Artcard 7410 contains, on the second surface thereof, instructions for the operation of the Artcam device so as to cause the combining effect. Turning to Fig. 331, there is illustrated an example of the operation of the repetition card so as to produce combined effects. The Artcam system will have a sensed or stored image 7412 of a particular scene. The first step is to insert a repetition card 7413 which contains a code to modify the operation of the Artcam system so as to enter a repetition mode. Next, a first Artcard 7414 is inserted in the

Artcard reader which results in a first effect 7415 being applied to the image in accordance with the instructions on the Artcard 7414. Next, the repetition card is again inserted 7416 followed by a second Artcard 7417 which, produces a second effect 7418 which can be, for example, be the placement of a text message on the image 7418. Next, the repetition card is again inserted 7419 before a third Artcard 7420 is inserted so as to provide a further effect in the image 7421. The process of Fig. 331 can be iteratively continued in accordance with requirements so as to produce a desired output image. In this way, the apparatus previously described can be utilized with an increased flexibility for the production of combined effects from single effect Artcards. Further, the user interface provided is simple and effective for the production of combined effects. Of course, many modifications can be provided. For example, in an alternative embodiment, the repetition card may only be inserted once and then a series of Artcards is inserted subsequent to the repetition card being inserted with the system resilient after printout.

Turning now to Fig. 333, there is illustrated an alternative Artcard 7430 which is provided for internal testing of the Artcam system. Each Artcam system can be provided with a number of internal test routines which are stored in the internal ROM of the Artcam system. The test can be accessed by specialised function calls in the interpretive language provided within the Artcam central processor. The routines can be Artcam device specific and can, for example, include:

the printing out of test patterns to determine the operational state of the print head;

the printing out of test patterns which result in the operational manipulation of the print head (for example, printing all black) so as to clean nozzles and to set up nozzle arrangements which result in improved operation of the print head;

test patterns can be printed for later analysis so as to show the effectiveness of the operation of the print head;

Turning to Fig. 334, there is illustrated an example test output 7435 which can include various informative internal data 7436 in addition to the printing out of test patterns 7437. The test patterns 7437. The test patterns 7437 can later be examined by means of automated or manual methods to determine any problems which may exist with the camera system. A further refinement can be implemented through the utilization of hard wired software routines programmed in the Artcam device and stored in ROM memory.

Of course, many refinements can be envisaged in that the routines can be updated and changed from model to model and the number of tests is virtually unlimited. In this way, the operation of the camera device can be modified in accordance with the inserted card.

<u>Art63 Description**</u>

<u>Art64 Description</u>

In a further refinement a magnetic sensitive print media material is utilized for the recording of an audio message on the back of an output photograph. The Artcam device is altered so as to include a magnetic recording device which can comprise an array of magnetic recorders covering a whole surface of the photograph or alternatively, a magnetic strip can be provided wherein, for example, a central portion of the photograph is magnetically sensitive. The Artcam devices are further provided with the ability to record an audio message for later playback.

In a further refinement, the Artcam device is suitably modified so as to equip it with a microphone device and associated recording technologies. When a picture is taken, the opportunity is provided to record either the

surrounding sound environment or a message associated with the image. The print media or film is pretreated so as to make it magnetically sensitive in a similar manner to that provided by tape media. The recording can be over the whole back surface of the output photo or alternatively a magnetically sensitive strip may be provided. The recorded audio is stored on the back of the output photograph in an encoded format, the encoding preferably being of a highly digital resilient form. The recorded audio provides a permanent audio record associated with the corresponding photograph. Subsequently, a playback apparatus is provided for scanning the encoded audio and decoding this information.

Turning now to Fig. 335, there is illustrated, in schematic form a further refinement 7601 which includes the arrangement as previously described wherein an image 7602 is sensed via a CCD sensor 7603 and forwarded to an Artcam central processor 7604. The Artcam central processor 7604 can store the image in memory 7605 which preferably comprises a high speed RAMBUS (Trade Mark) interfaced memory. The Artcam central processor 7604 is also responsible for controlling the operation of a printhead 7606 for the printing out of full color photographs, eg. 7607, so as to provide for instant images on demand in addition to the magnetic recording head 7616, for recording on the back of the photo.

In a further refinement, the camera arrangement 7601 is also supplied with a sound chip 7610 which interfaces via RAMBUS bus 7611 to memory 7605 under the control of the ACP processor 7604. The sound chip 7610 can be of a standard or specialised form and can, for example, comprise a DSP processor that takes an analogue input 7612 from a sound microphone 7613. Alternatively, with increasing chip complexities (Moore's Law), the functionality of sound chip 7610 can be incorporated onto the ACP chip 7604 which preferably comprises a leading edge CMOS type integrated circuit chip. It will be readily evident that many other types of arrangements can be provided which fall within the scope of the present invention.

The sound chip 7610 converts the analogue input 7612 to a corresponding digital form and forwards it for storage in memory 7605. The recording process can be activated by means of the depressing of a button (not shown) on the camera device, the button being under the control of the ACP processor 7604 otherwise it can be substantially automatic when taking a photo. The recorded data is stored in the memory 7605.

Turning now to Fig. 336, the camera arrangement preferably includes a printer device 7606 which includes a printhead utilized to print an image on print media 7617 and a magnetic recording head printhead 7616 being utilized to print information on the back of print output media 7617. Turning now to Fig. 337, there is illustrated an example output of a magnetic strip 7618 formed on the back of photo media 7617, the strip being recorded on by recording heading 7616 of Fig. 336. The information recorded can include location, date and time data with the location data being provided by means of keyboard input or, alternatively, through the utilization of attached positioning systems such as GPS or the like. Importantly, on the back of the image 7617 is also recorded an encoded form 7622 of the audio information. The format of the encoding can be many and various, however, preferably the encoding is provided in a highly fault tolerant manner so as to tolerate errors. The encoding format can heavily upon utilization of Reed-Solomon encoding of the data to provide for a high degree of fault tolerance.

Turning to Fig. 338, when it is desired to "play back" the recorded audio, the photo 7617 is passed through a reader device 7626 which includes pinch rollers for pinch rolling the photo 7617 passing a magnetic sensor device 7627.

Referring now to Fig. 339, there is illustrated in schematic form illustrating the operation of the audio reader device 7626 of Fig. 339. The magnetic sensor 7627 is interconnected to a second Artcam central processor 7628 which is suitably adapted to read and decode the data stored on the back of the photograph. The decoded audio information is stored in memory 7632 for playback via a sound processing chip 7633 on speaker 7629. The sound processing chip 7633 can operate under the control of the ACP decoder 7628 which in turn operates under the control of various user input controls 7633 which can include volume controls, rewind, play and fast forward controls etc.

It can be seen from the foregoing description of a further refinement that there is provided a system for the automatic recording of audio associated with an output image so as to provide an audio record associated with a photograph. There is also disclosed a audio reader system for reading an image recorded on the back of a photograph. It would be appreciated by a person skilled in the art that numerous variations and/or modifications any be made to the present invention as shown in the specific embodiment without departing from the spirit or scope of the invention as broadly described. For example, the utilization of more complex audio recording and playback techniques such as stereo and B-format techniques.

Art65 Description

In a further refinement, the aforementioned Artcam device is suitably programmed so as to print out "negatives" utilizing the printhead to print out a negative which conforms to a standard Artcard format such that the negative can be subsequently utilized by insertion into an Artcard sensor device so as to thereby allow the Artcard sensor device to sense the information stored on the "negative" Artcard and print out a corresponding photo.

Turning initially to Fig. 340, there is illustrated, in highly schematic form, a standard Artcam device 7701 which includes a sensor device 7702 for sensing an image on demand and a card reader sensor 7703 for sensing Artcard information. The sensors 7702 and 7703 operate under the control of an Artcam central processor 7704 which provides significant computational resources for the operation of the Artcam device. The Artcam central processor 7704 can include an onboard CPU in addition to a fully vectorisable very long instruction word (VLIW) central processor. The ACP 7704 is responsible for processing and decoding the sensed Artcard from Artcard reader 7703 in addition to the processing of any captured image 7702. The ACP 7704 interacts with memory 7705 so as to create a processed image which is printed out via printhead 7706 on to print media provided by an internal print roll so as to output a photo 7707. The Artcam system 7701 is designed to be constructed as a fully portable camera system having an internal disposable print roll for the provision of printing media and ink which is interconnected to printhead 7706 for the printing out of a photo 7707 on demand under the control of ACP processor 7704.

Turning now to Fig. 341, there is illustrated the steps 7710 in the operation of the Artcam system of Fig. 340 in accordance with a further refinement. In a further refinement, initially, a desired image is captured 7711 utilizing a first Artcam device. Next, the captured image is processed so as to provide a highly fault tolerant, resilient output data format. The processing can comprise compression of the image, duplicated data, Reed-Solomon encoding data in addition to pseudo randomly spreading out to the data over an array of data values. The output format can be exactly the same as that provided by "Artcard" devices as discussed previously in with the

addition of image compression where necessary. In addition to the Artcard output data, a thumb nail image of the sensed image is printed alongside the encoded data. Hence, this forms an Artcard "negative" for printing out 7712.

The Artcard arrangement can be as illustrated in Fig. 342 with the Artcam device 7701 capturing an image 7720 via a CCD sensor 7702 and outputting the result in an Artcam "negative" format 7721 which has the encoded highly resilient form of the sensed image 7722 in addition to a thumb nail 7724 of the input image. Although not shown in Fig. 342, the output is normally cut along line 7725 by a guillotine within the Artcam device 7701.

The data area 7722 is printed out with a series of border markers, eg. 7727, 7728 along each side border of the data area 7722. The markers 7727, 7728 are provided to accurately locate the data area 7722 when it is being scanned. Upon printing out of the "negative" 7721, the negative provides a permanent record of the contents of an image, similar to that provided by a photo negative which can then be stored in the usual manner of a photo negative. When it is desired to output a further, high quality copy of the captured image, the Artcard "negative" is inserted 7713 (Fig. 341) into the Artcard reader 7703 of the Artcam device of Fig. 342 wherein the Artcard data is decoded in the normal manner so as to provide the original image. The encoded data can include the original image and sufficient instructions to cause the image to be printed out by the Artcam device. The sensed card is decoded 7714 (Fig. 341) so as to derive the original picture which is subsequently printed out 7715 on demand as many times as required so as to provide an output of the sensed image. Hence, a system of providing a copy of the sensed image to a high resolution and in a highly resilient form is provided.

Alternative embodiments can also be constructed. For example, an arrangement can be utilized for automatically printing the "negative" data on the back of a photo surface. Such an arrangement is illustrated in Fig. 343 where there is shown the back of a photograph 7730 having data encoded area 7731 in addition to thumb nail portion 7732 printed on the back thereon. Hence, the data area 7731 can provide a permanent, highly accurate record of the image on the surface of the card 7730.

Art66 Description

In a futher refinement, an Artcard printer is provided which includes the ability to output a large number of Artcards in accordance with random output requirements. The production printer is interconnected to a network with other production printers and an overall computer system substantially controls the network so as to distribute Artcards in accordance with predetermined requirements. In this way, Artcard production is controlled so as to provide a high degree of flexibility.

Turning now to Fig. 344, there is illustrated, in somewhat schematic form, a single Artcard production printer 7801. The printer is based around two print heads 7802, 7803 with the print head 7802 for printing images on a top surface of the Artcard and the printer 7803 for printing an encoded version of the image manipulation instructions on a bottom surface of an Artcard. The print head 7802 can be a three color print head having ink supplies 7806. The bottom surface printer 7803 can be a single color print head having a single ink supply 7807. The printer 7801 operates under the control of a computer system for the printing out of Artcards on demand. After printing, a punch 7809 is provided for punching out the Artcards through a base plate 7810 which are then collected 7811 for distribution. The distribution being in accordance with predetermined regional requirements and distribution requirements of the region in which the Artcard printer 7801 is located.

Turning now to Fig. 345, there is illustrated the general arrangement of the controlling network 7820 of the Artcard distribution system. A series of printer computer devices e.g. 7821 are provided and interconnected together over a network 7822 which can take on various forms in accordance with requirements. The network 7822 and printer computers e.g. 7821 are controlled by a central organising computer 7823 which is responsible for the distribution of instructions to print Artcard combinations by the printer computers e.g. 7821. The printer computers e.g. 7821 can be regionally located in accordance with the requirements and demands. Alternatively, the printer computers may be centrally located, however, they are responsible for the distribution to various regions or directed to the satisfaction of various requirements. Each printer computer can include a large internal cache of Artcards. The cache can be located in memory, disc or on associated CD-ROMs which are distributed from time to time to each printer computer. A central organising computer is responsible for distribution of lists of Artcards to be printed out by the printer computers. Additionally, new Artcards can be loaded on to the central organising computer 7823 and distributed on demand to the associated printer computers e.g. 7821. The distribution taking the form of a cached distribution arrangement.

Turning to Fig. 346, there is illustrated one form of suitable arrangement 7830 of a printer computer. The arrangement 7830 is based around a core computer system 7831 which can comprise a high end PC type computer having significant memory and disc capacity. The computer system 7831 is interconnected to an Artcard printer 7832, the printer 7832 being substantially arranged in accordance with the arrangement of Fig. 344. The computer system 7831 includes a significant store of cached Artcards 7833 in addition to a network 7834. Hence, lists of Artcards to be printed out are forwarded from the central computer to each printer computer for the printing out of Artcards.

It can therefore be seen that, with the arrangement of Fig. 345, the significant combinatorial complexity distribution problem can be overcome and in an improved form of distribution system provided.

Ink Jet Technologies

The embodiments of the invention use an ink jet printer type device. Of course many different devices could be used. However presently popular ink jet printing technologies are unlikely to be suitable.

The most significant problem with thermal inkjet is power consumption. This is approximately 100 times that required for high speed, and stems from the energy-inefficient means of drop ejection. This involves the rapid boiling of water to produce a vapor bubble which expels the ink. Water has a very high heat capacity, and must be superheated in thermal inkjet applications. This leads to an efficiency of around 0.02%, from electricity input to drop momentum (and increased surface area) out.

The most significant problem with piezoelectric inkjet is size and cost. Piezoelectric crystals have a very small deflection at reasonable drive voltages, and therefore require a large area for each nozzle. Also, each piezoelectric actuator must be connected to its drive circuit on a separate substrate. This is not a significant problem at the current limit of around 300 nozzles per print head, but is a major impediment to the fabrication of pagewide print heads with 19,200 nozzles.

Ideally, the inkjet technologies used meet the stringent requirements of in-camera digital color printing and other high quality, high speed, low cost printing applications. To meet the requirements of digital photography, new inkjet technologies have been created. The target features include:

low power (less than 10 Watts)

high resolution capability (1,600 dpi or more)

photographic quality output

low manufacturing cost

small size (pagewidth times minimum cross section)

high speed (< 2 seconds per page).

All of these features can be met or exceeded by the inkjet systems described below with differing levels of difficulty. 45 different inkjet technologies have been developed by the Assignee to give a wide range of choices for high volume manufacture. These technologies form part of separate applications assigned to the present Assignee as set out in the table below.

The inkjet designs shown here are suitable for a wide range of digital printing systems, from battery powered one-time use digital cameras, through to desktop and network printers, and through to commercial printing systems

For ease of manufacture using standard process equipment, the print head is designed to be a monolithic 0.5 micron CMOS chip with MEMS post processing. For color photographic applications, the print head is 100 mm long, with a width which depends upon the inkjet type. The smallest print head designed is IJ38, which is 0.35 mm wide, giving a chip area of 35 square mm. The print heads each contain 19,200 nozzles plus data and control circuitry.

Ink is supplied to the back of the print head by injection molded plastic ink channels. The molding requires 50 micron features, which can be created using a lithographically micromachined insert in a standard injection molding tool. Ink flows through holes etched through the wafer to the nozzle chambers fabricated on the front surface of the wafer. The print head is connected to the camera circuitry by tape automated bonding.

Cross-Referenced Applications

The following table is a guide to cross-referenced patent applications filed concurrently herewith and discussed

hereinafter with the reference being utilized in subsequent tables when referring to a particular case:

Docket No.	Reference	Title
IJ01US	IJ01	Radiant Plunger Ink Jet Printer
IJ02US	IJ02	Electrostatic Ink Jet Printer
IJ03US	IJ03	Planar Thermoelastic Bend Actuator Ink Jet
IJ04US	IJ04	Stacked Electrostatic Ink Jet Printer
IJ05US	IJ05	Reverse Spring Lever Ink Jet Printer
IJ06US	IJ06	Paddle Type Ink Jet Printer
IJ07US	IJ07	Permanent Magnet Electromagnetic Ink Jet Printer
IJ08US	IJ08	Planar Swing Grill Electromagnetic Ink Jet Printer
IJ09US	IJ09	Pump Action Refill Ink Jet Printer
IJ10US	IJ10	Pulsed Magnetic Field Ink Jet Printer
IJ11US	IJ11	Two Plate Reverse Firing Electromagnetic Ink Jet Printer
IJ12US	IJ12	Linear Stepper Actuator Ink Jet Printer
IJ13US	IJ13	Gear Driven Shutter Ink Jet Printer
IJ14US	IJ14	Tapered Magnetic Pole Electromagnetic Ink Jet Printer
IJ15US	IJ15	Linear Spring Electromagnetic Grill Ink Jet Printer
IJ16US	IJ16	Lorenz Diaphragm Electromagnetic Ink Jet Printer
IJ17US	IJ17	PTFE Surface Shooting Shuttered Oscillating Pressure Ink Jet Printer
IJ18US	IJ18	Buckle Grip Oscillating Pressure Ink Jet Printer
IJ19US	IJ19	Shutter Based Ink Jet Printer
IJ20US	IJ20	Curling Calyx Thermoelastic Ink Jet Printer
IJ21US	IJ21	Thermal Actuated Ink Jet Printer
IJ22US	IJ22	Iris Motion Ink Jet Printer
IJ23US	IJ23	Direct Firing Thermal Bend Actuator Ink Jet Printer
IJ24US	IJ24	Conductive PTFE Ben Activator Vented Ink Jet Printer
IJ25US	IJ25	Magnetostrictive Ink Jet Printer
IJ26US	IJ26	Shape Memory Alloy Ink Jet Printer
IJ27US	IJ27	Buckle Plate Ink Jet Printer
IJ28US	IJ28	Thermal Elastic Rotary Impeller Ink Jet Printer
IJ29US	IJ29	Thermoelastic Bend Actuator Ink Jet Printer
IJ30US	IJ30	Thermoelastic Bend Actuator Using PTFE and Corrugated Copper Ink Jet Printer
IJ31US	IJ31	Bend Actuator Direct Ink Supply Ink Jet Printer
IJ32US	IJ32	A High Young's Modulus Thermoelastic Ink Jet Printer
IJ33US	IJ33	Thermally actuated slotted chamber wall ink jet printer
IJ34US	IJ34	Ink Jet Printer having a thermal actuator comprising an external coiled spring
IJ35US	IJ35	Trough Container Ink Jet Printer
IJ36US	IJ36	Dual Chamber Single Vertical Actuator Ink Jet
IJ37US	IJ37	Dual Nozzle Single Horizontal Fulcrum Actuator Ink Jet
IJ38US	IJ38	Dual Nozzle Single Horizontal Actuator Ink Jet
IJ39US	IJ39	A single bend actuator cupped paddle ink jet printing device
IJ40US	IJ40	A thermally actuated ink jet printer having a series of thermal actuator units
IJ41US	IJ41	A thermally actuated ink jet printer including a tapered heater element
IJ42US	IJ42	Radial Back-Curling Thermoelastic Ink Jet
IJ43US	IJ43	Inverted Radial Back-Curling Thermoelastic Ink Jet
IJ44US	IJ44	Surface bend actuator vented ink supply ink jet printer
IJ45US	IJ45	Coil Acutuated Magnetic Plate Ink Jet Printer

Tables of Drop-on-Demand Inkjets

Eleven important characteristics of the fundamental operation of individual inkjet nozzles have been identified. These characteristics are largely orthogonal, and so can be elucidated as an eleven dimensional matrix. Most of the eleven axes of this matrix include entries developed by the present assignee.

The following tables form the axes of an eleven dimensional table of inkjet types.

Actuator mechanism (18 types)

Basic operation mode (7 types)

Auxiliary mechanism (8 types)

Actuator amplification or modification method (17 types)

Actuator motion (19 types)

Nozzle refill method (4 types)

Method of restricting back-flow through inlet (10 types)

Nozzle clearing method (9 types)

Nozzle plate construction (9 types)

Drop ejection direction (5 types)

Ink type (7 types)

The complete eleven dimensional table represented by these axes contains 36.9 billion possible configurations of inkjet nozzle. While not all of the possible combinations result in a viable inkjet technology, many million configurations are viable. It is clearly impractical to elucidate all of the possible configurations. Instead, certain inkjet types have been investigated in detail. These are designated IJ01 to IJ45 above.

Other inkjet configurations can readily be derived from these 45 examples by substituting alternative configurations along one or more of the 11 axes. Most of the IJ01 to IJ45 examples can be made into inkjet print heads with characteristics superior to any currently available inkjet technology.

Where there are prior art examples known to the inventor, one or more of these examples are listed in the examples column of the tables below. The IJ01 to IJ45 series are also listed in the examples column. In some cases, a printer may be listed more than once in a table, where it shares characteristics with more than one entry.

Suitable applications include: Home printers, Office network printers, Short run digital printers, Commercial print systems, Fabric printers, Pocket printers, Internet WWW printers, Video printers, Medical imaging, Wide format printers, Notebook PC printers, Fax machines, Industrial printing systems, Photocopiers, Photographic minilabs etc.

The information associated with the aforementioned 11 dimensional matrix are set out in the following tables.

ACTUATOR MECHANISM (APPLIED ONLY TO SELECTED INK DROPS)

Actuator Mechanism	Description	Advantages	Disadvantages	Examples
Thermal bubble	An electrothermal heater heats the ink to above boiling point, transferring significant heat to the aqueous ink. A bubble nucleates and quickly forms, expelling the ink. The efficiency of the process is low, with typically less than 0.05% of the electrical energy being transformed into kinetic energy of the drop.	♦ Large force generated ♦ Simple construction ♦ No moving parts ♦ Fast operation ♦ Small chip area required for actuator	♦ High power ♦ Ink carrier limited to water ♦ Low efficiency ♦ High temperatures required ♦ High mechanical stress ♦ Unusual materials required ♦ Large drive transistors ♦ Cavitation causes actuator failure ♦ Kogation reduces bubble formation ♦ Large print heads are difficult to fabricate	♦ Canon Bubblejet 1979 Endo et al GB patent 2,007,162 ♦ Xerox heater-in-pit 1990 Hawkins et al USP 4,899,181 ♦ Hewlett-Packard TIJ 1982 Vaught et al USP 4,490,728
Piezoelectric	A piezoelectric crystal such as lead lanthanum zirconate (PZT) is electrically activated, and either expands, shears, or bends to apply pressure to the ink, ejecting drops.	♦ Low power consumption ♦ Many ink types can be used ♦ Fast operation ♦ High efficiency	♦ Very large area required for actuator ♦ Difficult to integrate with electronics ♦ High voltage drive transistors required ♦ Full pagewidth print heads impractical due to actuator size ♦ Requires electrical poling in high field strengths during manufacture	♦ Kyser et al USP 3,946,398 ♦ Zoltan USP 3,683,212 ♦ 1973 Stemme USP 3,747,120 ♦ Epson Stylus ♦ Tektronix ♦ IJ04
Electro-strictive	An electric field is used to activate electrostriction in relaxor materials such as lead lanthanum zirconate titanate (PLZT) or lead magnesium niobate (PMN).	♦ Low power consumption ♦ Many ink types can be used ♦ Low thermal expansion ♦ Electric field strength required (approx. 3.5 V/μ m) can be generated without difficulty ♦ Does not require electrical poling	♦ Low maximum strain (approx. 0.01%) ♦ Large area required for actuator due to low strain ♦ Response speed is marginal (~ 10 μs) ♦ High voltage drive transistors required ♦ Full pagewidth print heads impractical due to actuator size	♦ Seiko Epson, Usui et all JP 253401/96 ♦ IJ04

Ferroelectric	An electric field is used to induce a phase transition between the antiferroelectric (AFE) and ferroelectric (FE) phase. Perovskite materials such as tin modified lead lanthanum zirconate titanate (PLZSnT) exhibit large strains of up to 1% associated with the AFE to FE phase transition.	♦ Low power consumption ♦ Many ink types can be used ♦ Fast operation (< 1 μs) ♦ Relatively high longitudinal strain ♦ High efficiency ♦ Electric field strength of around 3 V/μm can be readily provided	♦ Difficult to integrate with electronics ♦ Unusual materials such as PLZSnT are required ♦ Actuators require a large area	♦ IJ04
Electrostatic plates	Conductive plates are separated by a compressible or fluid dielectric (usually air). Upon application of a voltage, the plates attract each other and displace ink, causing drop ejection. The conductive plates may be in a comb or honeycomb structure, or stacked to increase the surface area and therefore the force.	♦ Low power consumption ♦ Many ink types can be used ♦ Fast operation	♦ Difficult to operate electrostatic devices in an aqueous environment ♦ The electrostatic actuator will normally need to be separated from the ink ♦ Very large area required to achieve high forces ♦ High voltage drive transistors may be required ♦ Full pagewidth print heads are not competitive due to actuator size	♦ IJ02, IJ04
Electrostatic pull on ink	A strong electric field is applied to the ink, whereupon electrostatic attraction accelerates the ink towards the print medium.	♦ Low current consumption ♦ Low temperature	♦ High voltage required ♦ May be damaged by sparks due to air breakdown ♦ Required field strength increases as the drop size decreases ♦ High voltage drive transistors required ♦ Electrostatic field attracts dust	♦ 1989 Saito et al, USP 4,799,068 ♦ 1989 Miura et al, USP 4,810,954 ♦ Tone-jet

Permanent magnet electro-magnetic	An electromagnet directly attracts a permanent magnet, displacing ink and causing drop ejection. Rare earth magnets with a field strength around 1 Tesla can be used. Examples are: Samarium Cobalt (SaCo) and magnetic materials in the neodymium iron boron family (NdFeB, NdDyFeBNb, NdDyFeB, etc)	♦ Low power consumption ♦ Many ink types can be used ♦ Fast operation ♦ High efficiency ♦ Easy extension from single nozzles to pagewidth print heads	♦ Complex fabrication ♦ Permanent magnetic material such as Neodymium Iron Boron (NdFeB) required. ♦ High local currents required ♦ Copper metalization should be used for long electromigration lifetime and low resistivity ♦ Pigmented inks are usually infeasible ♦ Operating temperature limited to the Curie temperature (around 540 K)	♦ IJ07, IJ10
Soft magnetic core electro-magnetic	A solenoid induced a magnetic field in a soft magnetic core or yoke fabricated from a ferrous material such as electroplated iron alloys such as CoNiFe [1], CoFe, or NiFe alloys. Typically, the soft magnetic material is in two parts, which are normally held apart by a spring. When the solenoid is actuated, the two parts attract, displacing the ink.	♦ Low power consumption ♦ Many ink types can be used ♦ Fast operation ♦ High efficiency ♦ Easy extension from single nozzles to pagewidth print heads	♦ Complex fabrication ♦ Materials not usually present in a CMOS fab such as NiFe, CoNiFe, or CoFe are required ♦ High local currents required ♦ Copper metalization should be used for long electromigration lifetime and low resistivity ♦ Electroplating is required ♦ High saturation flux density is required (2.0-2.1 T is achievable with CoNiFe [1])	♦ IJ01, IJ05, IJ08, IJ10 ♦ IJ12, IJ14, IJ15, IJ17
Magnetic Lorenz force	The Lorenz force acting on a current carrying wire in a magnetic field is utilized. This allows the magnetic field to be supplied externally to the print head, for example with rare earth permanent magnets. Only the current carrying wire need be fabricated on the print-head, simplifying materials requirements.	♦ Low power consumption ♦ Many ink types can be used ♦ Fast operation ♦ High efficiency ♦ Easy extension from single nozzles to pagewidth print heads	♦ Force acts as a twisting motion ♦ Typically, only a quarter of the solenoid length provides force in a useful direction ♦ High local currents required ♦ Copper metalization should be used for long electromigration lifetime and low resistivity ♦ Pigmented inks are usually infeasible	♦ IJ06, IJ11, IJ13, IJ16

Magneto-striction	The actuator uses the giant magnetostrictive effect of materials such as Terfenol-D (an alloy of terbium, dysprosium and iron developed at the Naval Ordnance Laboratory, hence Ter-Fe-NOL). For best efficiency, the actuator should be pre-stressed to approx. 8 MPa.	♦ Many ink types can be used ♦ Fast operation ♦ Easy extension from single nozzles to pagewidth print heads ♦ High force is available	♦ Force acts as a twisting motion ♦ Unusual materials such as Terfenol-D are required ♦ High local currents required ♦ Copper metalization should be used for long electromigration lifetime and low resistivity ♦ Pre-stressing may be required	♦ Fischenbeck, USP 4,032,929 ♦ IJ25
Surface tension reduction	Ink under positive pressure is held in a nozzle by surface tension. The surface tension of the ink is reduced below the bubble threshold, causing the ink to egress from the nozzle.	♦ Low power consumption ♦ Simple construction ♦ No unusual materials required in fabrication ♦ High efficiency ♦ Easy extension from single nozzles to pagewidth print heads	♦ Requires supplementary force to effect drop separation ♦ Requires special ink surfactants ♦ Speed may be limited by surfactant properties	♦ Silverbrook, EP 0771 658 A2 and related patent applications
Viscosity reduction	The ink viscosity is locally reduced to select which drops are to be ejected. A viscosity reduction can be achieved electrothermally with most inks, but special inks can be engineered for a 100:1 viscosity reduction.	♦ Simple construction ♦ No unusual materials required in fabrication ♦ Easy extension from single nozzles to pagewidth print heads	♦ Requires supplementary force to effect drop separation ♦ Requires special ink viscosity properties ♦ High speed is difficult to achieve ♦ Requires oscillating ink pressure ♦ A high temperature difference (typically 80 degrees) is required	♦ Silverbrook, EP 0771 658 A2 and related patent applications
Acoustic	An acoustic wave is generated and focussed upon the drop ejection region.	♦ Can operate without a nozzle plate	♦ Complex drive circuitry ♦ Complex fabrication ♦ Low efficiency ♦ Poor control of drop position ♦ Poor control of drop volume	♦ 1993 Hadimioglu et al, EUP 550,192 ♦ 1993 Elrod et al, EUP 572,220

Thermoelastic bend actuator	An actuator which relies upon differential thermal expansion upon Joule heating is used.	♦ Low power consumption ♦ Many ink types can be used ♦ Simple planar fabrication ♦ Small chip area required for each actuator ♦ Fast operation ♦ High efficiency ♦ CMOS compatible voltages and currents ♦ Standard MEMS processes can be used ♦ Easy extension from single nozzles to pagewidth print heads	♦ Efficient aqueous operation requires a thermal insulator on the hot side ♦ Corrosion prevention can be difficult ♦ Pigmented inks may be infeasible, as pigment particles may jam the bend actuator	♦ IJ03, IJ09, IJ17, IJ18 ♦ IJ19, IJ20, IJ21, IJ22 ♦ IJ23, IJ24, IJ27, IJ28 ♦ IJ29, IJ30, IJ31, IJ32 ♦ IJ33, IJ34, IJ35, IJ36 ♦ IJ37, IJ38 ,IJ39, IJ40 ♦ IJ41
High CTE thermoelastic actuator	A material with a very high coefficient of thermal expansion (CTE) such as polytetrafluoroethylene (PTFE) is used. As high CTE materials are usually non-conductive, a heater fabricated from a conductive material is incorporated. A 50 µm long PTFE bend actuator with polysilicon heater and 15 mW power input can provide 180 µN force and 10 µm deflection. Actuator motions include: 1) Bend 2) Push 3) Buckle 4) Rotate	♦ High force can be generated ♦ PTFE is a candidate for low dielectric constant insulation in ULSI ♦ Very low power consumption ♦ Many ink types can be used ♦ Simple planar fabrication ♦ Small chip area required for each actuator ♦ Fast operation ♦ High efficiency ♦ CMOS compatible voltages and currents ♦ Easy extension from single nozzles to pagewidth print heads	♦ Requires special material (e.g. PTFE) ♦ Requires a PTFE deposition process, which is not yet standard in ULSI fabs ♦ PTFE deposition cannot be followed with high temperature (above 350 °C) processing ♦ Pigmented inks may be infeasible, as pigment particles may jam the bend actuator	♦ IJ09, IJ17, IJ18, IJ20 ♦ IJ21, IJ22, IJ23, IJ24 ♦ IJ27, IJ28, IJ29, IJ30 ♦ IJ31, IJ42, IJ43, IJ44

Conductive polymer thermoelastic actuator	A polymer with a high coefficient of thermal expansion (such as PTFE) is doped with conducting substances to increase its conductivity to about 3 orders of magnitude below that of copper. The conducting polymer expands when resistively heated. Examples of conducting dopants include: 1) Carbon nanotubes 2) Metal fibers 3) Conductive polymers such as doped polythiophene 4) Carbon granules	♦ High force can be generated ♦ Very low power consumption ♦ Many ink types can be used ♦ Simple planar fabrication ♦ Small chip area required for each actuator ♦ Fast operation ♦ High efficiency ♦ CMOS compatible voltages and currents ♦ Easy extension from single nozzles to pagewidth print heads	♦ Requires special materials development (High CTE conductive polymer) ♦ Requires a PTFE deposition process, which is not yet standard in ULSI fabs ♦ PTFE deposition cannot be followed with high temperature (above 350 °C) processing ♦ Evaporation and CVD deposition techniques cannot be used ♦ Pigmented inks may be infeasible, as pigment particles may jam the bend actuator	♦ IJ24
Shape memory alloy	A shape memory alloy such as TiNi (also known as Nitinol - Nickel Titanium alloy developed at the Naval Ordnance Laboratory) is thermally switched between its weak martensitic state and its high stiffness austenic state. The shape of the actuator in its martensitic state is deformed relative to the austenic shape. The shape change causes ejection of a drop.	♦ High force is available (stresses of hundreds of MPa) ♦ Large strain is available (more than 3%) ♦ High corrosion resistance ♦ Simple construction ♦ Easy extension from single nozzles to pagewidth print heads ♦ Low voltage operation	♦ Fatigue limits maximum number of cycles ♦ Low strain (1%) is required to extend fatigue resistance ♦ Cycle rate limited by heat removal ♦ Requires unusual materials (TiNi) ♦ The latent heat of transformation must be provided ♦ High current operation ♦ Requires pre-stressing to distort the martensitic state	♦ IJ26
Linear Magnetic Actuator	Linear magnetic actuators include the Linear Induction Actuator (LIA), Linear Permanent Magnet Synchronous Actuator (LPMSA), Linear Reluctance Synchronous Actuator (LRSA), Linear Switched Reluctance Actuator (LSRA), and the Linear Stepper Actuator (LSA).	♦ Linear Magnetic actuators can be constructed with high thrust, long travel, and high efficiency using planar semiconductor fabrication techniques ♦ Long actuator travel is available ♦ Medium force is available ♦ Low voltage operation	♦ Requires unusual semiconductor materials such as soft magnetic alloys (e.g. CoNiFe [1]) ♦ Some varieties also require permanent magnetic materials such as Neodymium iron boron (NdFeB) ♦ Requires complex multi-phase drive circuitry ♦ High current operation	♦ IJ12

BASIC OPERATION MODE

Operational mode	Description	Advantages	Disadvantages	Examples
Actuator directly pushes ink	This is the simplest mode of operation: the actuator directly supplies sufficient kinetic energy to expel the drop. The drop must have a sufficient velocity to overcome the surface tension.	♦ Simple operation ♦ No external fields required ♦ Satellite drops can be avoided if drop velocity is less than 4 m/s ♦ Can be efficient, depending upon the actuator used	♦ Drop repetition rate is usually limited to less than 10 KHz. However, this is not fundamental to the method, but is related to the refill method normally used ♦ All of the drop kinetic energy must be provided by the actuator ♦ Satellite drops usually form if drop velocity is greater than 4.5 m/s	♦ Thermal inkjet ♦ Piezoelectric inkjet ♦ IJ01, IJ02, IJ03, IJ04 ♦ IJ05, IJ06, IJ07, IJ09 ♦ IJ11, IJ12, IJ14, IJ16 ♦ IJ20, IJ22, IJ23, IJ24 ♦ IJ25, IJ26, IJ27, IJ28 ♦ IJ29, IJ30, IJ31, IJ32 ♦ IJ33, IJ34, IJ35, IJ36 ♦ IJ37, IJ38, IJ39, IJ40 ♦ IJ41, IJ42, IJ43, IJ44
Proximity	The drops to be printed are selected by some manner (e.g. thermally induced surface tension reduction of pressurized ink). Selected drops are separated from the ink in the nozzle by contact with the print medium or a transfer roller.	♦ Very simple print head fabrication can be used ♦ The drop selection means does not need to provide the energy required to separate the drop from the nozzle	♦ Requires close proximity between the print head and the print media or transfer roller ♦ May require two print heads printing alternate rows of the image ♦ Monolithic color print heads are difficult	♦ Silverbrook, EP 0771 658 A2 and related patent applications
Electrostatic pull on ink	The drops to be printed are selected by some manner (e.g. thermally induced surface tension reduction of pressurized ink). Selected drops are separated from the ink in the nozzle by a strong electric field.	♦ Very simple print head fabrication can be used ♦ The drop selection means does not need to provide the energy required to separate the drop from the nozzle	♦ Requires very high electrostatic field ♦ Electrostatic field for small nozzle sizes is above air breakdown ♦ Electrostatic field may attract dust	♦ Silverbrook, EP 0771 658 A2 and related patent applications ♦ Tone-Jet
Magnetic pull on ink	The drops to be printed are selected by some manner (e.g. thermally induced surface tension reduction of pressurized ink). Selected drops are separated from the ink in the nozzle by a strong magnetic field acting on the magnetic ink.	♦ Very simple print head fabrication can be used ♦ The drop selection means does not need to provide the energy required to separate the drop from the nozzle	♦ Requires magnetic ink ♦ Ink colors other than black are difficult ♦ Requires very high magnetic fields	♦ Silverbrook, EP 0771 658 A2 and related patent applications

Shutter	The actuator moves a shutter to block ink flow to the nozzle. The ink pressure is pulsed at a multiple of the drop ejection frequency.	♦ High speed (>50 KHz) operation can be achieved due to reduced refill time ♦ Drop timing can be very accurate ♦ The actuator energy can be very low	♦ Moving parts are required ♦ Requires ink pressure modulator ♦ Friction and wear must be considered ♦ Stiction is possible	♦ IJ13, IJ17, IJ21
Shuttered grill	The actuator moves a shutter to block ink flow through a grill to the nozzle. The shutter movement need only be equal to the width of the grill holes.	♦ Actuators with small travel can be used ♦ Actuators with small force can be used ♦ High speed (>50 KHz) operation can be achieved	♦ Moving parts are required ♦ Requires ink pressure modulator ♦ Friction and wear must be considered ♦ Stiction is possible	♦ IJ08, IJ15, IJ18, IJ19
Pulsed magnetic pull on ink pusher	A pulsed magnetic field attracts an 'ink pusher' at the drop ejection frequency. An actuator controls a catch, which prevents the ink pusher from moving when a drop is not to be ejected.	♦ Extremely low energy operation is possible ♦ No heat dissipation problems	♦ Requires an external pulsed magnetic field ♦ Requires special materials for both the actuator and the ink pusher ♦ Complex construction	♦ IJ10

AUXILIARY MECHANISM (APPLIED TO ALL NOZZLES)

Auxiliary Mechanism	Description	Advantages	Disadvantages	Examples
None	The actuator directly fires the ink drop, and there is no external field or other mechanism required.	♦ Simplicity of construction ♦ Simplicity of operation ♦ Small physical size	♦ Drop ejection energy must be supplied by individual nozzle actuator	♦ Most inkjets, including piezoelectric and thermal bubble. ♦ IJ01- IJ07, IJ09, IJ11 ♦ IJ12, IJ14, IJ20, IJ22 ♦ IJ23-IJ45
Oscillating ink pressure (including acoustic stimulation)	The ink pressure oscillates, providing much of the drop ejection energy. The actuator selects which drops are to be fired by selectively blocking or enabling nozzles. The ink pressure oscillation may be achieved by vibrating the print head, or preferably by an actuator in the ink supply.	♦ Oscillating ink pressure can provide a refill pulse, allowing higher operating speed ♦ The actuators may operate with much lower energy ♦ Acoustic lenses can be used to focus the sound on the nozzles	♦ Requires external ink pressure oscillator ♦ Ink pressure phase and amplitude must be carefully controlled ♦ Acoustic reflections in the ink chamber must be designed for	♦ Silverbrook, EP 0771 658 A2 and related patent applications ♦ IJ08, IJ13, IJ15, IJ17 ♦ IJ18, IJ19, IJ21
Media proximity	The print head is placed in close proximity to the print medium. Selected drops protrude from the print head further than unselected drops, and contact the print medium. The drop soaks into the medium fast enough to cause drop separation.	♦ Low power ♦ High accuracy ♦ Simple print head construction	♦ Precision assembly required ♦ Paper fibers may cause problems ♦ Cannot print on rough substrates	♦ Silverbrook, EP 0771 658 A2 and related patent applications
Transfer roller	Drops are printed to a transfer roller instead of straight to the print medium. A transfer roller can also be used for proximity drop separation.	♦ High accuracy ♦ Wide range of print substrates can be used ♦ Ink can be dried on the transfer roller	♦ Bulky ♦ Expensive ♦ Complex construction	♦ Silverbrook, EP 0771 658 A2 and related patent applications ♦ Tektronix hot melt piezoelectric inkjet ♦ Any of the IJ series
Electrostatic	An electric field is used to accelerate selected drops towards the print medium.	♦ Low power ♦ Simple print head construction	♦ Field strength required for separation of small drops is near or above air breakdown	♦ Silverbrook, EP 0771 658 A2 and related patent applications ♦ Tone-Jet

Direct magnetic field	A magnetic field is used to accelerate selected drops of magnetic ink towards the print medium.	♦ Low power ♦ Simple print head construction	♦ Requires magnetic ink ♦ Requires strong magnetic field	♦ Silverbrook, EP 0771 658 A2 and related patent applications
Cross magnetic field	The print head is placed in a constant magnetic field. The Lorenz force in a current carrying wire is used to move the actuator.	♦ Does not require magnetic materials to be integrated in the print head manufacturing process	♦ Requires external magnet ♦ Current densities may be high, resulting in electromigration problems	♦ IJ06, IJ16
Pulsed magnetic field	A pulsed magnetic field is used to cyclically attract a paddle, which pushes on the ink. A small actuator moves a catch, which selectively prevents the paddle from moving.	♦ Very low power operation is possible ♦ Small print head size	♦ Complex print head construction ♦ Magnetic materials required in print head	♦ IJ10

ACTUATOR AMPLIFICATION OR MODIFICATION METHOD

Actuator amplification	Description	Advantages	Disadvantages	Examples
None	No actuator mechanical amplification is used. The actuator directly drives the drop ejection process.	♦ Operational simplicity	♦ Many actuator mechanisms have insufficient travel, or insufficient force, to efficiently drive the drop ejection process	♦ Thermal Bubble Inkjet ♦ IJ01, IJ02, IJ06, IJ07 ♦ IJ16, IJ25, IJ26
Differential expansion bend actuator	An actuator material expands more on one side than on the other. The expansion may be thermal, piezoelectric, magnetostrictive, or other mechanism.	♦ Provides greater travel in a reduced print head area ♦ The bend actuator converts a high force low travel actuator mechanism to high travel, lower force mechanism.	♦ High stresses are involved ♦ Care must be taken that the materials do not delaminate ♦ Residual bend resulting from high temperature or high stress during formation	♦ Piezoelectric ♦ IJ03, IJ09, IJ17-IJ24 ♦ IJ27, IJ29-IJ39, IJ42, ♦ IJ43, IJ44
Transient bend actuator	A trilayer bend actuator where the two outside layers are identical. This cancels bend due to ambient temperature and residual stress. The actuator only responds to transient heating of one side or the other.	♦ Very good temperature stability ♦ High speed, as a new drop can be fired before heat dissipates ♦ Cancels residual stress of formation	♦ High stresses are involved ♦ Care must be taken that the materials do not delaminate	♦ IJ40, IJ41
Actuator stack	A series of thin actuators are stacked. This can be appropriate where actuators require high electric field strength, such as electrostatic and piezoelectric actuators.	♦ Increased travel ♦ Reduced drive voltage	♦ Increased fabrication complexity ♦ Increased possibility of short circuits due to pinholes	♦ Some piezoelectric ink jets ♦ IJ04
Multiple actuators	Multiple smaller actuators are used simultaneously to move the ink. Each actuator need provide only a portion of the force required.	♦ Increases the force available from an actuator ♦ Multiple actuators can be positioned to control ink flow accurately	♦ Actuator forces may not add linearly, reducing efficiency	♦ IJ12, IJ13, IJ18, IJ20 ♦ IJ22, IJ28, IJ42, IJ43
Linear Spring	A linear spring is used to transform a motion with small travel and high force into a longer travel, lower force motion.	♦ Matches low travel actuator with higher travel requirements ♦ Non-contact method of motion transformation	♦ Requires print head area for the spring	♦ IJ15

Reverse spring	The actuator loads a spring. When the actuator is turned off, the spring releases. This can reverse the force/distance curve of the actuator to make it compatible with the force/time requirements of the drop ejection.	♦ Better coupling to the ink	♦ Fabrication complexity ♦ High stress in the spring	♦ IJ05, IJ11
Coiled actuator	A bend actuator is coiled to provide greater travel in a reduced chip area.	♦ Increases travel ♦ Reduces chip area ♦ Planar implementations are relatively easy to fabricate.	♦ Generally restricted to planar implementations due to extreme fabrication difficulty in other orientations.	♦ IJ17, IJ21, IJ34, IJ35
Flexure bend actuator	A bend actuator has a small region near the fixture point, which flexes much more readily than the remainder of the actuator. The actuator flexing is effectively converted from an even coiling to an angular bend, resulting in greater travel of the actuator tip.	♦ Simple means of increasing travel of a bend actuator	♦ Care must be taken not to exceed the elastic limit in the flexure area ♦ Stress distribution is very uneven ♦ Difficult to accurately model with finite element analysis	♦ IJ10, IJ19, IJ33
Gears	Gears can be used to increase travel at the expense of duration. Circular gears, rack and pinion, ratchets, and other gearing methods can be used.	♦ Low force, low travel actuators can be used ♦ Can be fabricated using standard surface MEMS processes	♦ Moving parts are required ♦ Several actuator cycles are required ♦ More complex drive electronics ♦ Complex construction ♦ Friction, friction, and wear are possible	♦ IJ13
Catch	The actuator controls a small catch. The catch either enables or disables movement of an ink pusher that is controlled in a bulk manner.	♦ Very low actuator energy ♦ Very small actuator size	♦ Complex construction ♦ Requires external force ♦ Unsuitable for pigmented inks	♦ IJ10
Buckle plate	A buckle plate can be used to change a slow actuator into a fast motion. It can also convert a high force, low travel actuator into a high travel, medium force motion.	♦ Very fast movement achievable	♦ Must stay within elastic limits of the materials for long device life ♦ High stresses involved ♦ Generally high power requirement	♦ S. Hirata et al, "An Ink-jet Head ...", Proc. IEEE MEMS, Feb. 1996, pp 418-423. ♦ IJ18, IJ27
Tapered magnetic pole	A tapered magnetic pole can increase travel at the expense of force.	♦ Linearizes the magnetic force/distance curve	♦ Complex construction	♦ IJ14

Lever	A lever and fulcrum is used to transform a motion with small travel and high force into a motion with longer travel and lower force. The lever can also reverse the direction of travel.	♦ Matches low travel actuator with higher travel requirements ♦ Fulcrum area has no linear movement, and can be used for a fluid seal	♦ High stress around the fulcrum	♦ IJ32, IJ36, IJ37
Rotary impeller	The actuator is connected to a rotary impeller. A small angular deflection of the actuator results in a rotation of the impeller vanes, which push the ink against stationary vanes and out of the nozzle.	♦ High mechanical advantage ♦ The ratio of force to travel of the actuator can be matched to the nozzle requirements by varying the number of impeller vanes	♦ Complex construction ♦ Unsuitable for pigmented inks	♦ IJ28
Acoustic lens	A refractive or diffractive (e.g. zone plate) acoustic lens is used to concentrate sound waves.	♦ No moving parts	♦ Large area required ♦ Only relevant for acoustic ink jets	♦ 1993 Hadimioglu et al, EUP 550,192 ♦ 1993 Elrod et al, EUP 572,220
Sharp conductive point	A sharp point is used to concentrate an electrostatic field.	♦ Simple construction	♦ Difficult to fabricate using standard VLSI processes for a surface ejecting ink-jet ♦ Only relevant for electrostatic ink jets	♦ Tone-jet

ACTUATOR MOTION

Actuator motion	Description	Advantages	Disadvantages	Examples
Volume expansion	The volume of the actuator changes, pushing the ink in all directions.	♦ Simple construction in the case of thermal ink jet	♦ High energy is typically required to achieve volume expansion. This leads to thermal stress, cavitation, and kogation in thermal ink jet implementations	♦ Hewlett-Packard Thermal Inkjet ♦ Canon Bubblejet
Linear, normal to chip surface	The actuator moves in a direction normal to the print head surface. The nozzle is typically in the line of movement.	♦ Efficient coupling to ink drops ejected normal to the surface	♦ High fabrication complexity may be required to achieve perpendicular motion	♦ IJ01, IJ02, IJ04, IJ07 ♦ IJ11, IJ14
Linear, parallel to chip surface	The actuator moves parallel to the print head surface. Drop ejection may still be normal to the surface.	♦ Suitable for planar fabrication	♦ Fabrication complexity ♦ Friction ♦ Stiction	♦ IJ12, IJ13, IJ15, IJ33, ♦ IJ34, IJ35, IJ36
Membrane push	An actuator with a high force but small area is used to push a stiff membrane that is in contact with the ink.	♦ The effective area of the actuator becomes the membrane area	♦ Fabrication complexity ♦ Actuator size ♦ Difficulty of integration in a VLSI process	♦ 1982 Howkins USP 4,459,601
Rotary	The actuator causes the rotation of some element, such a grill or impeller	♦ Rotary levers may be used to increase travel ♦ Small chip area requirements	♦ Device complexity ♦ May have friction at a pivot point	♦ IJ05, IJ08, IJ13, IJ28
Bend	The actuator bends when energized. This may be due to differential thermal expansion, piezoelectric expansion, magnetostriction, or other form of relative dimensional change.	♦ A very small change in dimensions can be converted to a large motion.	♦ Requires the actuator to be made from at least two distinct layers, or to have a thermal difference across the actuator	♦ 1970 Kyser et al USP 3,946,398 ♦ 1973 Stemme USP 3,747,120 ♦ IJ03, IJ09, IJ10, IJ19 ♦ IJ23, IJ24, IJ25, IJ29 ♦ IJ30, IJ31, IJ33, IJ34 ♦ IJ35
Swivel	The actuator swivels around a central pivot. This motion is suitable where there are opposite forces applied to opposite sides of the paddle, e.g. Lorenz force.	♦ Allows operation where the net linear force on the paddle is zero ♦ Small chip area requirements	♦ Inefficient coupling to the ink motion	♦ IJ06

Straighten	The actuator is normally bent, and straightens when energized.	♦ Can be used with shape memory alloys where the austenic phase is planar	♦ Requires careful balance of stresses to ensure that the quiescent bend is accurate	♦ IJ26, IJ32
Double bend	The actuator bends in one direction when one element is energized, and bends the other way when another element is energized.	♦ One actuator can be used to power two nozzles. ♦ Reduced chip size. ♦ Not sensitive to ambient temperature	♦ Difficult to make the drops ejected by both bend directions identical. ♦ A small efficiency loss compared to equivalent single bend actuators.	♦ IJ36, IJ37, IJ38
Shear	Energizing the actuator causes a shear motion in the actuator material.	♦ Can increase the effective travel of piezoelectric actuators	♦ Not readily applicable to other actuator mechanisms	♦ 1985 Fishbeck USP 4,584,590
Radial constriction	The actuator squeezes an ink reservoir, forcing ink from a constricted nozzle.	♦ Relatively easy to fabricate single nozzles from glass tubing as macroscopic structures	♦ High force required ♦ Inefficient ♦ Difficult to integrate with VLSI processes	♦ 1970 Zoltan USP 3,683,212
Coil / uncoil	A coiled actuator uncoils or coils more tightly. The motion of the free end of the actuator ejects the ink.	♦ Easy to fabricate as a planar VLSI process ♦ Small area required, therefore low cost	♦ Difficult to fabricate for non-planar devices ♦ Poor out-of-plane stiffness	♦ IJ17, IJ21, IJ34, IJ35
Bow	The actuator bows (or buckles) in the middle when energized.	♦ Can increase the speed of travel ♦ Mechanically rigid	♦ Maximum travel is constrained ♦ High force required	♦ IJ16, IJ18, IJ27
Push-Pull	Two actuators control a shutter. One actuator pulls the shutter, and the other pushes it.	♦ The structure is pinned at both ends, so has a high out-of-plane rigidity	♦ Not readily suitable for inkjets which directly push the ink	♦ IJ18
Curl inwards	A set of actuators curl inwards to reduce the volume of ink that they enclose.	♦ Good fluid flow to the region behind the actuator increases efficiency	♦ Design complexity	♦ IJ20, IJ42
Curl outwards	A set of actuators curl outwards, pressurizing ink in a chamber surrounding the actuators, and expelling ink from a nozzle in the chamber.	♦ Relatively simple construction	♦ Relatively large chip area	♦ IJ43

Iris	Multiple vanes enclose a volume of ink. These simultaneously rotate, reducing the volume between the vanes.	♦ High efficiency ♦ Small chip area	♦ High fabrication complexity ♦ Not suitable for pigmented inks	♦ IJ22
Acoustic vibration	The actuator vibrates at a high frequency.	♦ The actuator can be physically distant from the ink	♦ Large area required for efficient operation at useful frequencies ♦ Acoustic coupling and crosstalk ♦ Complex drive circuitry ♦ Poor control of drop volume and position	♦ 1993 Hadimioglu et al, EUP 550,192 ♦ 1993 Elrod et al, EUP 572,220
None	In various ink jet designs the actuator does not move.	♦ No moving parts	♦ Various other tradeoffs are required to eliminate moving parts	♦ Silverbrook, EP 0771 658 A2 and related patent applications ♦ Tone-jet

NOZZLE REFILL METHOD

Nozzle refill method	Description	Advantages	Disadvantages	Examples
Surface tension	After the actuator is energized, it typically returns rapidly to its normal position. This rapid return sucks in air through the nozzle opening. The ink surface tension at the nozzle then exerts a small force restoring the meniscus to a minimum area.	♦ Fabrication simplicity ♦ Operational simplicity	♦ Low speed ♦ Surface tension force relatively small compared to actuator force ♦ Long refill time usually dominates the total repetition rate	♦ Thermal inkjet ♦ Piezoelectric inkjet ♦ IJ01-IJ07, IJ10-IJ14 ♦ IJ16, IJ20, IJ22-IJ45
Shuttered oscillating ink pressure	Ink to the nozzle chamber is provided at a pressure that oscillates at twice the drop ejection frequency. When a drop is to be ejected, the shutter is opened for 3 half cycles: drop ejection, actuator return, and refill.	♦ High speed ♦ Low actuator energy, as the actuator need only open or close the shutter, instead of ejecting the ink drop	♦ Requires common ink pressure oscillator ♦ May not be suitable for pigmented inks	♦ IJ08, IJ13, IJ15, IJ17 ♦ IJ18, IJ19, IJ21
Refill actuator	After the main actuator has ejected a drop a second (refill) actuator is energized. The refill actuator pushes ink into the nozzle chamber. The refill actuator returns slowly, to prevent its return from emptying the chamber again.	♦ High speed, as the nozzle is actively refilled	♦ Requires two independent actuators per nozzle	♦ IJ09
Positive ink pressure	The ink is held a slight positive pressure. After the ink drop is ejected, the nozzle chamber fills quickly as surface tension and ink pressure both operate to refill the nozzle.	♦ High refill rate, therefore a high drop repetition rate is possible	♦ Surface spill must be prevented ♦ Highly hydrophobic print head surfaces are required	♦ Silverbrook, EP 0771 658 A2 and related patent applications ♦ Alternative for: ♦ IJ01-IJ07, IJ10-IJ14 ♦ IJ16, IJ20, IJ22-IJ45

METHOD OF RESTRICTING BACK-FLOW THROUGH INLET

Inlet back-flow restriction method	Description	Advantages	Disadvantages	Examples
Long inlet channel	The ink inlet channel to the nozzle chamber is made long and relatively narrow, relying on viscous drag to reduce inlet back-flow.	♦ Design simplicity ♦ Operational simplicity ♦ Reduces crosstalk	♦ Restricts refill rate ♦ May result in a relatively large chip area ♦ Only partially effective	♦ Thermal inkjet ♦ Piezoelectric inkjet ♦ IJ42, IJ43
Positive ink pressure	The ink is under a positive pressure, so that in the quiescent state some of the ink drop already protrudes from the nozzle. This reduces the pressure in the nozzle chamber which is required to eject a certain volume of ink. The reduction in chamber pressure results in a reduction in ink pushed out through the inlet.	♦ Drop selection and separation forces can be reduced ♦ Fast refill time	♦ Requires a method (such as a nozzle rim or effective hydrophobizing, or both) to prevent flooding of the ejection surface of the print head.	♦ Silverbrook, EP 0771 658 A2 and related patent applications ♦ Possible operation of the following: ♦ IJ01-IJ07, IJ09- IJ12 ♦ IJ14, IJ16, IJ20, IJ22, ♦ IJ23-IJ34, IJ36- IJ41 ♦ IJ44
Baffle	One or more baffles are placed in the inlet ink flow. When the actuator is energized, the rapid ink movement creates eddies which restrict the flow through the inlet. The slower refill process is unrestricted, and does not result in eddies.	♦ The refill rate is not as restricted as the long inlet method. ♦ Reduces crosstalk	♦ Design complexity ♦ May increase fabrication complexity (e.g. Tektronix hot melt Piezoelectric print heads).	♦ HP Thermal Ink Jet ♦ Tektronix piezoelectric ink jet
Flexible flap restricts inlet	In this method recently disclosed by Canon, the expanding actuator (bubble) pushes on a flexible flap that restricts the inlet.	♦ Significantly reduces back-flow for edge-shooter thermal ink jet devices	♦ Not applicable to most inkjet configurations ♦ Increased fabrication complexity ♦ Inelastic deformation of polymer flap results in creep over extended use	♦ Canon

Inlet filter	A filter is located between the ink inlet and the nozzle chamber. The filter has a multitude of small holes or slots, restricting ink flow. The filter also removes particles which may block the nozzle.	♦ Additional advantage of ink filtration ♦ Ink filter may be fabricated with no additional process steps	♦ Restricts refill rate ♦ May result in complex construction	♦ IJ04, IJ12, IJ24, IJ27 ♦ IJ29, IJ30
Small inlet compared to nozzle	The ink inlet channel to the nozzle chamber has a substantially smaller cross section than that of the nozzle , resulting in easier ink egress out of the nozzle than out of the inlet.	♦ Design simplicity	♦ Restricts refill rate ♦ May result in a relatively large chip area ♦ Only partially effective	♦ IJ02, IJ37, IJ44
Inlet shutter	A secondary actuator controls the position of a shutter, closing off the ink inlet when the main actuator is energized.	♦ Increases speed of the ink-jet print head operation	♦ Requires separate refill actuator and drive circuit	♦ IJ09
The inlet is located behind the ink-pushing surface	The method avoids the problem of inlet back-flow by arranging the ink-pushing surface of the actuator between the inlet and the nozzle.	♦ Back-flow problem is eliminated	♦ Requires careful design to minimize the negative pressure behind the paddle	♦ IJ01, IJ03, 1J05, IJ06 ♦ IJ07, IJ10, IJ11, IJ14 ♦ IJ16, IJ22, IJ23, IJ25 ♦ IJ28, IJ31, IJ32, IJ33 ♦ IJ34, IJ35, IJ36, IJ39 ♦ IJ40, IJ41
Part of the actuator moves to shut off the inlet	The actuator and a wall of the ink chamber are arranged so that the motion of the actuator closes off the inlet.	♦ Significant reductions in back-flow can be achieved ♦ Compact designs possible	♦ Small increase in fabrication complexity	♦ IJ07, IJ20, IJ26, IJ38
Nozzle actuator does not result in ink back-flow	In some configurations of ink jet, there is no expansion or movement of an actuator which may cause ink back-flow through the inlet.	♦ Ink back-flow problem is eliminated	♦ None related to ink back-flow on actuation	♦ Silverbrook, EP 0771 658 A2 and related patent applications ♦ Valve-jet ♦ Tone-jet ♦ IJ08, IJ13, IJ15, IJ17 ♦ IJ18, IJ19, IJ21

NOZZLE CLEARING METHOD

Nozzle Clearing method	Description	Advantages	Disadvantages	Examples
Normal nozzle firing	All of the nozzles are fired periodically, before the ink has a chance to dry. When not in use the nozzles are sealed (capped) against air. The nozzle firing is usually performed during a special clearing cycle, after first moving the print head to a cleaning station.	♦ No added complexity on the print head	♦ May not be sufficient to displace dried ink	♦ Most ink jet systems ♦ IJ01- IJ07, IJ09-IJ12 ♦ IJ14, IJ16, IJ20, IJ22 ♦ IJ23- IJ34, IJ36-IJ45
Extra power to ink heater	In systems which heat the ink, but do not boil it under normal situations, nozzle clearing can be achieved by over-powering the heater and boiling ink at the nozzle.	♦ Can be highly effective if the heater is adjacent to the nozzle	♦ Requires higher drive voltage for clearing ♦ May require larger drive transistors	♦ Silverbrook, EP 0771 658 A2 and related patent applications
Rapid succession of actuator pulses	The actuator is fired in rapid succession. In some configurations, this may cause heat build-up at the nozzle which boils the ink, clearing the nozzle. In other situations, it may cause sufficient vibrations to dislodge clogged nozzles.	♦ Does not require extra drive circuits on the print head ♦ Can be readily controlled and initiated by digital logic	♦ Effectiveness depends substantially upon the configuration of the inkjet nozzle	♦ May be used with: ♦ IJ01-IJ07, IJ09- IJ11 ♦ IJ14, IJ16, IJ20, IJ22 ♦ IJ23-IJ25, IJ27-IJ34 ♦ IJ36-IJ45
Extra power to ink pushing actuator	Where an actuator is not normally driven to the limit of its motion, nozzle clearing may be assisted by providing an enhanced drive signal to the actuator.	♦ A simple solution where applicable	♦ Not suitable where there is a hard limit to actuator movement	♦ May be used with: ♦ IJ03, IJ09, IJ16, IJ20 ♦ IJ23, IJ24, IJ25, IJ27 ♦ IJ29, IJ30, IJ31, IJ32 ♦ IJ39, IJ40, IJ41, IJ42 ♦ IJ43, IJ44, IJ45

Acoustic resonance	An ultrasonic wave is applied to the ink chamber. This wave is of an appropriate amplitude and frequency to cause sufficient force at the nozzle to clear blockages. This is easiest to achieve if the ultrasonic wave is at a resonant frequency of the ink cavity.	♦ A high nozzle clearing capability can be achieved ♦ May be implemented at very low cost in systems which already include acoustic actuators	♦ High implementation cost if system does not already include an acoustic actuator	♦ IJ08, IJ13, IJ15, IJ17 ♦ IJ18, IJ19, IJ21
Nozzle clearing plate	A microfabricated plate is pushed against the nozzles. The plate has a post for every nozzle. The array of posts	♦ Can clear severely clogged nozzles	♦ Accurate mechanical alignment is required ♦ Moving parts are required ♦ There is risk of damage to the nozzles ♦ Accurate fabrication is required	♦ Silverbrook, EP 0771 658 A2 and related patent applications
Ink pressure pulse	The pressure of the ink is temporarily increased so that ink streams from all of the nozzles. This may be used in conjunction with actuator energizing.	♦ May be effective where other methods cannot be used	♦ Requires pressure pump or other pressure actuator ♦ Expensive ♦ Wasteful of ink	♦ May be used with all IJ series ink jets
Print head wiper	A flexible 'blade' is wiped across the print head surface. The blade is usually fabricated from a flexible polymer, e.g. rubber or synthetic elastomer.	♦ Effective for planar print head surfaces ♦ Low cost	♦ Difficult to use if print head surface is non-planar or very fragile ♦ Requires mechanical parts ♦ Blade can wear out in high volume print systems	♦ Many ink jet systems
Separate ink boiling heater	A separate heater is provided at the nozzle although the normal drop e–ection mechanism does not require it. The heaters do not require individual drive circuits, as many nozzles can be cleared simultaneously, and no imaging is required.	♦ Can be effective where other nozzle clearing methods cannot be used ♦ Can be implemented at no additional cost in some inkjet configurations	♦ Fabrication complexity	♦ Can be used with many IJ series ink jets

NOZZLE PLATE CONSTRUCTION

Nozzle plate construction	Description	Advantages	Disadvantages	Examples
Electroformed nickel	A nozzle plate is separately fabricated from electroformed nickel, and bonded to the print head chip.	♦ Fabrication simplicity	♦ High temperatures and pressures are required to bond nozzle plate ♦ Minimum thickness constraints ♦ Differential thermal expansion	♦ Hewlett Packard Thermal Inkjet
Laser ablated or drilled polymer	Individual nozzle holes are ablated by an intense UV laser in a nozzle plate, which is typically a polymer such as polyimide or polysulphone	♦ No masks required ♦ Can be quite fast ♦ Some control over nozzle profile is possible ♦ Equipment required is relatively low cost	♦ Each hole must be individually formed ♦ Special equipment required ♦ Slow where there are many thousands of nozzles per print head ♦ May produce thin burrs at exit holes	♦ Canon Bubblejet ♦ 1988 Sercel et al., SPIE, Vol. 998 Excimer Beam Applications, pp. 76-83 ♦ 1993 Watanabe et al., USP 5,208,604
Silicon micro-machined	A separate nozzle plate is micromachined from single crystal silicon, and bonded to the print head wafer.	♦ High accuracy is attainable	♦ Two part construction ♦ High cost ♦ Requires precision alignment ♦ Nozzles may be clogged by adhesive	♦ K. Bean, IEEE Transactions on Electron Devices, Vol. ED-25, No. 10, 1978, pp 1185-1195 ♦ Xerox 1990 Hawkins et al., USP 4,899,181
Glass capillaries	Fine glass capillaries are drawn from glass tubing. This method has been used for making individual nozzles, but is difficult to use for bulk manufacturing of print heads with thousands of nozzles.	♦ No expensive equipment required ♦ Simple to make single nozzles	♦ Very small nozzle sizes are difficult to form ♦ Not suited for mass production	♦ 1970 Zoltan USP 3,683,212

Monolithic, surface micro-machined using VLSI lithographic processes	The nozzle plate is deposited as a layer using standard VLSI deposition techniques. Nozzles are etched in the nozzle plate using VLSI lithography and etching.	♦ High accuracy (<1 µm) ♦ Monolithic ♦ Low cost ♦ Existing processes can be used	♦ Requires sacrificial layer under the nozzle plate to form the nozzle chamber ♦ Surface may be fragile to the touch	♦ Silverbrook, EP 0771 658 A2 and related patent applications ♦ IJ01, IJ02, IJ04, IJ11 ♦ IJ12, IJ17, IJ18, IJ20 ♦ IJ22, IJ24, IJ27, IJ28 ♦ IJ29, IJ30, IJ31, IJ32 ♦ IJ33, IJ34, IJ36, IJ37 ♦ IJ38, IJ39, IJ40, IJ41 ♦ IJ42, IJ43, IJ44
Monolithic, etched through substrate	The nozzle plate is a buried etch stop in the wafer. Nozzle chambers are etched in the front of the wafer, and the wafer is thinned from the back side. Nozzles are then etched in the etch stop layer.	♦ High accuracy (<1 µm) ♦ Monolithic ♦ Low cost ♦ No differential expansion	♦ Requires long etch times ♦ Requires a support wafer	♦ IJ03, IJ05, IJ06, IJ07 ♦ IJ08, IJ09, IJ10, IJ13 ♦ IJ14, IJ15, IJ16, IJ19 ♦ IJ21, IJ23, IJ25, IJ26
No nozzle plate	Various methods have been tried to eliminate the nozzles entirely, to prevent nozzle clogging. These include thermal bubble mechanisms and acoustic lens mechanisms	♦ No nozzles to become clogged	♦ Difficult to control drop position accurately ♦ Crosstalk problems	♦ Ricoh 1995 Sekiya et al USP 5,412,413 ♦ 1993 Hadimioglu et al EUP 550,192 ♦ 1993 Elrod et al EUP 572,220
Trough	Each drop ejector has a trough through which a paddle moves. There is no nozzle plate.	♦ Reduced manufacturing complexity ♦ Monolithic	♦ Drop firing direction is sensitive to wicking.	♦ IJ35
Nozzle slit instead of individual nozzles	The elimination of nozzle holes and replacement by a slit encompassing many actuator positions reduces nozzle clogging, but increases crosstalk due to ink surface waves	♦ No nozzles to become clogged	♦ Difficult to control drop position accurately ♦ Crosstalk problems	♦ 1989 Saito et al USP 4,799,068

DROP EJECTION DIRECTION

Ejection direction	Description	Advantages	Disadvantages	Examples
Edge ('edge shooter')	Ink flow is along the surface of the chip, and ink drops are ejected from the chip edge.	♦ Simple construction ♦ No silicon etching required ♦ Good heat sinking via substrate ♦ Mechanically strong ♦ Ease of chip handing	♦ Nozzles limited to edge ♦ High resolution is difficult ♦ Fast color printing requires one print head per color	♦ Canon Bubblejet 1979 Endo et al GB patent 2,007,162 ♦ Xerox heater-in-pit 1990 Hawkins et al USP 4,899,181 ♦ Tone-jet
Surface ('roof shooter')	Ink flow is along the surface of the chip, and ink drops are ejected from the chip surface, normal to the plane of the chip.	♦ No bulk silicon etching required ♦ Silicon can make an effective heat sink ♦ Mechanical strength	♦ Maximum ink flow is severely restricted	♦ Hewlett-Packard TIJ 1982 Vaught et al USP 4,490,728 ♦ IJ02, IJ11, IJ12, IJ20 ♦ IJ22
Through chip, forward ('up shooter')	Ink flow is through the chip, and ink drops are ejected from the front surface of the chip.	♦ High ink flow ♦ Suitable for pagewidth print ♦ High nozzle packing density therefore low manufacturing cost	♦ Requires bulk silicon etching	♦ Silverbrook, EP 0771 658 A2 and related patent applications ♦ IJ04, IJ17, IJ18, IJ24 ♦ IJ27-IJ45
Through chip, reverse ('down shooter')	Ink flow is through the chip, and ink drops are ejected from the rear surface of the chip.	♦ High ink flow ♦ Suitable for pagewidth print ♦ High nozzle packing density therefore low manufacturing cost	♦ Requires wafer thinning ♦ Requires special handling during manufacture	♦ IJ01, IJ03, IJ05, IJ06 ♦ IJ07, IJ08, IJ09, IJ10 ♦ IJ13, IJ14, IJ15, IJ16 ♦ IJ19, IJ21, IJ23, IJ25 ♦ IJ26
Through actuator	Ink flow is through the actuator, which is not fabricated as part of the same substrate as the drive transistors.	♦ Suitable for piezoelectric print heads	♦ Pagewidth print heads require several thousand connections to drive circuits ♦ Cannot be manufactured in standard CMOS fabs ♦ Complex assembly required	♦ Epson Stylus ♦ Tektronix hot melt piezoelectric ink jets

INK TYPE

Ink type	Description	Advantages	Disadvantages	Examples
Aqueous, dye	Water based ink which typically contains: water, dye, surfactant, humectant, and biocide. Modern ink dyes have high water-fastness, light fastness	♦ Environmentally friendly ♦ No odor	♦ Slow drying ♦ Corrosive ♦ Bleeds on paper ♦ May strikethrough ♦ Cockles paper	♦ Most existing inkjets ♦ All IJ series ink jets ♦ Silverbrook, EP 0771 658 A2 and related patent applications
Aqueous, pigment	Water based ink which typically contains: water, pigment, surfactant, humectant, and biocide. Pigments have an advantage in reduced bleed, wicking and strikethrough.	♦ Environmentally friendly ♦ No odor ♦ Reduced bleed ♦ Reduced wicking ♦ Reduced strikethrough	♦ Slow drying ♦ Corrosive ♦ Pigment may clog nozzles ♦ Pigment may clog actuator mechanisms ♦ Cockles paper	♦ IJ02, IJ04, IJ21, IJ26 ♦ IJ27, IJ30 ♦ Silverbrook, EP 0771 658 A2 and related patent applications ♦ Piezoelectric ink-jets ♦ Thermal ink jets (with significant restrictions)
Methyl Ethyl Ketone (MEK)	MEK is a highly volatile solvent used for industrial printing on difficult surfaces such as aluminum cans.	♦ Very fast drying ♦ Prints on various substrates such as metals and plastics	♦ Odorous ♦ Flammable	♦ All IJ series ink jets
Alcohol **(ethanol, 2-butanol, and others)**	Alcohol based inks can be used where the printer must operate at temperatures below the freezing point of water. An example of this is in-camera consumer photographic printing.	♦ Fast drying ♦ Operates at sub-freezing temperatures ♦ Reduced paper cockle ♦ Low cost	♦ Slight odor ♦ Flammable	♦ All IJ series ink jets

Phase change (hot melt)	The ink is solid at room temperature, and is melted in the print head before jetting. Hot melt inks are usually wax based, with a melting point around 80 ° C. After jetting the ink freezes almost instantly upon contacting the print medium or a transfer roller.	♦ No drying time- ink instantly freezes on the print medium ♦ Almost any print medium can be used ♦ No paper cockle occurs ♦ No wicking occurs ♦ No bleed occurs ♦ No strikethrough occurs	♦ High viscosity ♦ Printed ink typically has a 'waxy' feel ♦ Printed pages may 'block' ♦ Ink temperature may be above the curie point of permanent magnets ♦ Ink heaters consume power ♦ Long warm-up time	♦ Tektronix hot melt piezoelectric ink jets ♦ 1989 Nowak USP 4,820,346 ♦ All IJ series ink jets
Oil	Oil based inks are extensively used in offset printing. They have advantages in improved characteristics on paper (especially no wicking or cockle). Oil soluble dies and pigments are required.	♦ High solubility medium for some dyes ♦ Does not cockle paper ♦ Does not wick through paper	♦ High viscosity: this is a significant limitation for use in inkjets, which usually require a low viscosity. Some short chain and multi-branched oils have a sufficiently low viscosity. ♦ Slow drying	♦ All IJ series ink jets
Microemulsion	A microemulsion is a stable, self forming emulsion of oil, water, and surfactant. The characteristic drop size is less than 100 nm, and is determined by the preferred curvature of the surfactant.	♦ Stops ink bleed ♦ High dye solubility ♦ Water, oil, and amphiphilic soluble dies can be used ♦ Can stabilize pigment suspensions	♦ Viscosity higher than water ♦ Cost is slightly higher than water based ink ♦ High surfactant concentration required (around 5%)	♦ All IJ series ink jets

Ink Jet Printing

A large number of new forms of ink jet printers have been developed to facilitate alternative ink jet technologies for the image processing and data distribution system. Various combinations of ink jet devices can be included in printer devices incorporated as part of the present invention. Australian Provisional Patent Applications relating to these ink jets which are specifically incorporated by cross reference include:

Australian Provisional Number	Filing Date	Title
PO8066	15-Jul-97	Image Creation Method and Apparatus (IJ01)
PO8072	15-Jul-97	Image Creation Method and Apparatus (IJ02)
PO8040	15-Jul-97	Image Creation Method and Apparatus (IJ03)
PO8071	15-Jul-97	Image Creation Method and Apparatus (IJ04)
PO8047	15-Jul-97	Image Creation Method and Apparatus (IJ05)
PO8035	15-Jul-97	Image Creation Method and Apparatus (IJ06)
PO8044	15-Jul-97	Image Creation Method and Apparatus (IJ07)
PO8063	15-Jul-97	Image Creation Method and Apparatus (IJ08)
PO8057	15-Jul-97	Image Creation Method and Apparatus (IJ09)
PO8056	15-Jul-97	Image Creation Method and Apparatus (IJ10)
PO8069	15-Jul-97	Image Creation Method and Apparatus (IJ11)
PO8049	15-Jul-97	Image Creation Method and Apparatus (IJ12)
PO8036	15-Jul-97	Image Creation Method and Apparatus (IJ13)
PO8048	15-Jul-97	Image Creation Method and Apparatus (IJ14)
PO8070	15-Jul-97	Image Creation Method and Apparatus (IJ15)
PO8067	15-Jul-97	Image Creation Method and Apparatus (IJ16)
PO8001	15-Jul-97	Image Creation Method and Apparatus (IJ17)
PO8038	15-Jul-97	Image Creation Method and Apparatus (IJ18)
PO8033	15-Jul-97	Image Creation Method and Apparatus (IJ19)
PO8002	15-Jul-97	Image Creation Method and Apparatus (IJ20)
PO8068	15-Jul-97	Image Creation Method and Apparatus (IJ21)
PO8062	15-Jul-97	Image Creation Method and Apparatus (IJ22)
PO8034	15-Jul-97	Image Creation Method and Apparatus (IJ23)
PO8039	15-Jul-97	Image Creation Method and Apparatus (IJ24)
PO8041	15-Jul-97	Image Creation Method and Apparatus (IJ25)
PO8004	15-Jul-97	Image Creation Method and Apparatus (IJ26)
PO8037	15-Jul-97	Image Creation Method and Apparatus (IJ27)
PO8043	15-Jul-97	Image Creation Method and Apparatus (IJ28)
PO8042	15-Jul-97	Image Creation Method and Apparatus (IJ29)
PO8064	15-Jul-97	Image Creation Method and Apparatus (IJ30)
PO9389	23-Sep-97	Image Creation Method and Apparatus (IJ31)
PO9391	23-Sep-97	Image Creation Method and Apparatus (IJ32)
PP0888	12-Dec-97	Image Creation Method and Apparatus (IJ33)

PP0891	12-Dec-97	Image Creation Method and Apparatus (IJ34)
PP0890	12-Dec-97	Image Creation Method and Apparatus (IJ35)
PP0873	12-Dec-97	Image Creation Method and Apparatus (IJ36)
PP0993	12-Dec-97	Image Creation Method and Apparatus (IJ37)
PP0890	12-Dec-97	Image Creation Method and Apparatus (IJ38)
PP1398	19-Jan-98	An Image Creation Method and Apparatus (IJ39)
PP2592	25-Mar-98	An Image Creation Method and Apparatus (IJ40)
PP2593	25-Mar-98	Image Creation Method and Apparatus (IJ41)
PP3991	9-Jun-98	Image Creation Method and Apparatus (IJ42)
PP3987	9-Jun-98	Image Creation Method and Apparatus (IJ43)
PP3985	9-Jun-98	Image Creation Method and Apparatus (IJ44)
PP3983	9-Jun-98	Image Creation Method and Apparatus (IJ45)

Ink Jet Manufacturing

Further, the present application may utilize advanced semiconductor fabrication techniques in the construction of large arrays of ink jet printers. Suitable manufacturing techniques are described in the following Australian provisional patent specifications incorporated here by cross-reference:

Australian Provisional Number	Filing Date	Title
PO7935	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM01)
PO7936	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM02)
PO7937	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM03)
PO8061	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM04)
PO8054	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM05)
PO8065	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM06)
PO8055	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM07)
PO8053	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM08)
PO8078	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM09)
PO7933	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM10)
PO7950	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM11)
PO7949	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM12)
PO8060	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM13)
PO8059	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM14)
PO8073	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM15)
PO8076	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM16)
PO8075	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM17)
PO8079	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM18)
PO8050	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM19)
PO8052	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM20)
PO7948	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM21)

PO7951	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM22)
PO8074	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM23)
PO7941	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM24)
PO8077	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM25)
PO8058	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM26)
PO8051	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM27)
PO8045	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM28)
PO7952	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM29)
PO8046	15-Jul-97	A Method of Manufacture of an Image Creation Apparatus (IJM30)
PO8503	11-Aug-97	A Method of Manufacture of an Image Creation Apparatus (IJM30a)
PO9390	23-Sep-97	A Method of Manufacture of an Image Creation Apparatus (IJM31)
PO9392	23-Sep-97	A Method of Manufacture of an Image Creation Apparatus (IJM32)
PP0889	12-Dec-97	A Method of Manufacture of an Image Creation Apparatus (IJM35)
PP0887	12-Dec-97	A Method of Manufacture of an Image Creation Apparatus (IJM36)
PP0882	12-Dec-97	A Method of Manufacture of an Image Creation Apparatus (IJM37)
PP0874	12-Dec-97	A Method of Manufacture of an Image Creation Apparatus (IJM38)
PP1396	19-Jan-98	A Method of Manufacture of an Image Creation Apparatus (IJM39)
PP2591	25-Mar-98	A Method of Manufacture of an Image Creation Apparatus (IJM41)
PP3989	9-Jun-98	A Method of Manufacture of an Image Creation Apparatus (IJM40)
PP3990	9-Jun-98	A Method of Manufacture of an Image Creation Apparatus (IJM42)
PP3986	9-Jun-98	A Method of Manufacture of an Image Creation Apparatus (IJM43)
PP3984	9-Jun-98	A Method of Manufacture of an Image Creation Apparatus (IJM44)
PP3982	9-Jun-98	A Method of Manufacture of an Image Creation Apparatus (IJM45)

Fluid Supply

Further, the present application may utilize an ink delivery system to the ink jet head. Delivery systems relating to the supply of ink to a series of ink jet nozzles are described in the following Australian provisional patent specifications, the disclosure of which are hereby incorporated by cross-reference:

Australian Provisional Number	Filing Date	Title
PO8003	15-Jul-97	Supply Method and Apparatus (F1)
PO8005	15-Jul-97	Supply Method and Apparatus (F2)
PO9404	23-Sep-97	A Device and Method (F3)

MEMS Technology

Further, the present application may utilize advanced semiconductor microelectromechanical techniques in the construction of large arrays of ink jet printers. Suitable microelectromechanical techniques are described in the following Australian provisional patent specifications incorporated here by cross-reference:

Australian Provisional Number	Filing Date	Title
PO7943	15-Jul-97	A device (MEMS01)
PO8006	15-Jul-97	A device (MEMS02)
PO8007	15-Jul-97	A device (MEMS03)
PO8008	15-Jul-97	A device (MEMS04)
PO8010	15-Jul-97	A device (MEMS05)
PO8011	15-Jul-97	A device (MEMS06)
PO7947	15-Jul-97	A device (MEMS07)
PO7945	15-Jul-97	A device (MEMS08)
PO7944	15-Jul-97	A device (MEMS09)
PO7946	15-Jul-97	A device (MEMS10)
PO9393	23-Sep-97	A Device and Method (MEMS11)
PP0875	12-Dec-97	A Device (MEMS12)
PP0894	12-Dec-97	A Device and Method (MEMS13)

IR Technologies

Further, the present application may include the utilization of a disposable camera system such as those described in the following Australian provisional patent specifications incorporated here by cross-reference:

Australian Provisional Number	Filing Date	Title
PP0895	12-Dec-97	An Image Creation Method and Apparatus (IR01)
PP0870	12-Dec-97	A Device and Method (IR02)
PP0869	12-Dec-97	A Device and Method (IR04)
PP0887	12-Dec-97	Image Creation Method and Apparatus (IR05)
PP0885	12-Dec-97	An Image Production System (IR06)
PP0884	12-Dec-97	Image Creation Method and Apparatus (IR10)
PP0886	12-Dec-97	Image Creation Method and Apparatus (IR12)
PP0871	12-Dec-97	A Device and Method (IR13)
PP0876	12-Dec-97	An Image Processing Method and Apparatus (IR14)
PP0877	12-Dec-97	A Device and Method (IR16)
PP0878	12-Dec-97	A Device and Method (IR17)
PP0879	12-Dec-97	A Device and Method (IR18)
PP0883	12-Dec-97	A Device and Method (IR19)
PP0880	12-Dec-97	A Device and Method (IR20)
PP0881	12-Dec-97	A Device and Method (IR21)

DotCard Technologies

Further, the present application may include the utilization of a data distribution system such as that described in the following Australian provisional patent specifications incorporated here by cross-reference:

Australian Provisional Number	Filing Date	Title
PP2370	16-Mar-98	Data Processing Method and Apparatus (Dot01)
PP2371	16-Mar-98	Data Processing Method and Apparatus (Dot02)

Artcam Technologies

Further, the present application may include the utilization of camera and data processing techniques such as an Artcam type device as described in the following Australian provisional patent specifications incorporated here by cross-reference:

Australian Provisional Number	Filing Date	Title
PO7991	15-Jul-97	Image Processing Method and Apparatus (ART01)
PO8505	11-Aug-97	Image Processing Method and Apparatus (ART01a)
PO7988	15-Jul-97	Image Processing Method and Apparatus (ART02)
PO7993	15-Jul-97	Image Processing Method and Apparatus (ART03)
PO8012	15-Jul-97	Image Processing Method and Apparatus (ART05)
PO8017	15-Jul-97	Image Processing Method and Apparatus (ART06)
PO8014	15-Jul-97	Media Device (ART07)
PO8025	15-Jul-97	Image Processing Method and Apparatus (ART08)
PO8032	15-Jul-97	Image Processing Method and Apparatus (ART09)
PO7999	15-Jul-97	Image Processing Method and Apparatus (ART10)
PO7998	15-Jul-97	Image Processing Method and Apparatus (ART11)
PO8031	15-Jul-97	Image Processing Method and Apparatus (ART12)
PO8030	15-Jul-97	Media Device (ART13)
PO8498	11-Aug-97	Image Processing Method and Apparatus (ART14)
PO7997	15-Jul-97	Media Device (ART15)
PO7979	15-Jul-97	Media Device (ART16)
PO8015	15-Jul-97	Media Device (ART17)
PO7978	15-Jul-97	Media Device (ART18)
PO7982	15-Jul-97	Data Processing Method and Apparatus (ART19)
PO7989	15-Jul-97	Data Processing Method and Apparatus (ART20)
PO8019	15-Jul-97	Media Processing Method and Apparatus (ART21)
PO7980	15-Jul-97	Image Processing Method and Apparatus (ART22)
PO7942	15-Jul-97	Image Processing Method and Apparatus (ART23)
PO8018	15-Jul-97	Image Processing Method and Apparatus (ART24)
PO7938	15-Jul-97	Image Processing Method and Apparatus (ART25)
PO8016	15-Jul-97	Image Processing Method and Apparatus (ART26)
PO8024	15-Jul-97	Image Processing Method and Apparatus (ART27)
PO7940	15-Jul-97	Data Processing Method and Apparatus (ART28)
PO7939	15-Jul-97	Data Processing Method and Apparatus (ART29)
PO8501	11-Aug-97	Image Processing Method and Apparatus (ART30)
PO8500	11-Aug-97	Image Processing Method and Apparatus (ART31)
PO7987	15-Jul-97	Data Processing Method and Apparatus (ART32)
PO8022	15-Jul-97	Image Processing Method and Apparatus (ART33)
PO8497	11-Aug-97	Image Processing Method and Apparatus (ART30)

PO8029	15-Jul-97	Sensor Creation Method and Apparatus (ART36)
PO7985	15-Jul-97	Data Processing Method and Apparatus (ART37)
PO8020	15-Jul-97	Data Processing Method and Apparatus (ART38)
PO8023	15-Jul-97	Data Processing Method and Apparatus (ART39)
PO9395	23-Sep-97	Data Processing Method and Apparatus (ART4)
PO8021	15-Jul-97	Data Processing Method and Apparatus (ART40)
PO8504	11-Aug-97	Image Processing Method and Apparatus (ART42)
PO8000	15-Jul-97	Data Processing Method and Apparatus (ART43)
PO7977	15-Jul-97	Data Processing Method and Apparatus (ART44)
PO7934	15-Jul-97	Data Processing Method and Apparatus (ART45)
PO7990	15-Jul-97	Data Processing Method and Apparatus (ART46)
PO8499	11-Aug-97	Image Processing Method and Apparatus (ART47)
PO8502	11-Aug-97	Image Processing Method and Apparatus (ART48)
PO7981	15-Jul-97	Data Processing Method and Apparatus (ART50)
PO7986	15-Jul-97	Data Processing Method and Apparatus (ART51)
PO7983	15-Jul-97	Data Processing Method and Apparatus (ART52)
PO8026	15-Jul-97	Image Processing Method and Apparatus (ART53)
PO8027	15-Jul-97	Image Processing Method and Apparatus (ART54)
PO8028	15-Jul-97	Image Processing Method and Apparatus (ART56)
PO9394	23-Sep-97	Image Processing Method and Apparatus (ART57)
PO9396	23-Sep-97	Data Processing Method and Apparatus (ART58)
PO9397	23-Sep-97	Data Processing Method and Apparatus (ART59)
PO9398	23-Sep-97	Data Processing Method and Apparatus (ART60)
PO9399	23-Sep-97	Data Processing Method and Apparatus (ART61)
PO9400	23-Sep-97	Data Processing Method and Apparatus (ART62)
PO9401	23-Sep-97	Data Processing Method and Apparatus (ART63)
PO9402	23-Sep-97	Data Processing Method and Apparatus (ART64)
PO9403	23-Sep-97	Data Processing Method and Apparatus (ART65)
PO9405	23-Sep-97	Data Processing Method and Apparatus (ART66)
PP0959	16-Dec-97	A Data Processing Method and Apparatus (ART68)
PP1397	19-Jan-98	A Media Device (ART69)

It would be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiment without departing from the spirit or scope of the invention as broadly described. The present embodiment is, therefore, to be considered in all respects to be illustrative and not restrictive.

We claim:

1. A camera system comprising:

at least one area image sensor for imaging a scene;

a camera processor means for processing said image scene in accordance with a predetermined scene transformation requirement; and

a printer for printing out said processed image scene on print media, utilizing printing ink stored in a single detachable module inside said camera system;

said camera system comprising a portable hand held unit for the imaging of scenes by said area image sensor and printing said scenes directly out of said camera system via said printer.

2. A camera processor as claimed in claim 1 further comprising a print roll for the storage of print media and printing ink for utilization by said printer, said print roll being detachable from said camera system.

3. A camera system as claimed in claim 2 wherein said print roll includes an authentication chip containing authentication information and said camera processing means is adapted to interrogate said authentication chip so as to determine the authenticity of said print roll when inserted within said camera system.

4. A camera system as claimed in claim 1 wherein said printer comprises a drop on demand ink printer.

5. A camera system as in claim 1 further comprising a guillotine means for the separation of printed photographs.

6. A camera system as claimed in claim 1 wherein the number of area image sensors is at least 2 and said camera processor means includes means for deriving a stereoscopic image from said area image sensors and said print media includes means for stereoscopic imaging of said stereo images so as to produce a three dimensional effect.

7. A user interface for operating a device, said user interface comprising a card which is inserted in a machine and on the face of the card is contained a visual representation of the effect the card will have on the output of the machine.

8. A user interface as claimed in claim 7 wherein said machine comprises a camera device capable of transforming a sensed image substantially in accordance with the transformation of a standard image comprising said visual representation.

9. A user interface as claimed in claim 8 wherein said camera includes and integral printer and said transformation of said sensed image is printed out on said printer.

10. A user interface as claimed in claim 7 wherein said machine comprises a book reader and said card includes a books contents for display by said book reader as indicated by the visual representation on the front of said card.

11. A user interface as claimed in claim 7 wherein said card comprises, on one surface, the visual representation of said effect, and on a second surface, a visually encoded representation of said effect able to be read by a sensing device of said machine and decoded so as to produce said effect.

12. The camera system comprising:

at least one area image sensor for imaging a scene;

a camera processor means for processing said imaged scene in accordance with a predetermined scene transformation requirement;

a printer for printing out said processed image scene on print media;

a detachable module for storing said print media and printing ink for said printer;

said camera system comprising a portable hand held unit for the imaging of scenes by said area image sensor and printing said scenes directly out of said camera system via said printer.

13. A camera processor as claimed in claim 12 further comprising a print roll unit for the storage of print media and printing ink for utilization by said printer, said print roll being detachable from said camera system.

14. A camera system as claimed in claim 13 wherein said print roll includes an authentication chip containing authentication information and said camera processing means is adapted to interrogate said authentication chip so as to determine the authenticity of said print roll when inserted within said camera system.

15. A camera system as claimed in claim 12 wherein said printer comprises a drop on demand ink jet printer.

16. A camera system as in claim 12 further comprising a guillotine means for the separation of printed photographs.

17. A camera system as claimed in claim 12 wherein the number of area image sensors is at least two and said camera processor means includes means for deriving a stereoscopic image from said area image sensors and said print media includes means for stereoscopic imaging of said stereo images so as to produce a three dimensional affect.

18. A camera system comprising:

sensor means for sensing an image;

processing means for processing said sensed image in accordance with a predetermined processing requirement, if any;

audio recording means for according an audio signal to be associated with said sensed image;

printer means for printing said processed sensed image on a first area of a print media supplied with said camera system, in addition to printing an encoded version of said audio signal on a second area of said print media.

19. A camera system as claimed in claim 18 wherein said sensed image is printed on a first surface of said print media and said encoded version of said audio signal is printed on a second surface of said print media.

20. A camera system as claimed in claim 18 wherein said print media is supplied in said camera system on a detachable print roll.

21. A camera system as claimed in claim 18 wherein said printer means includes at least one ink jet print head for printing said processed sensed image in addition to a second print head for printing said encoded version of said audio signal.

22. A camera system as claimed in claim 18 wherein said encoding comprises Reed-Solomon encoding of said audio-signal.

23. A camera system as claimed in claim 18 wherein said encoded version is modulated with a high frequency component to assist in sensing of said encoded version.

24. A camera system as claimed in claim 23 wherein said high frequency component comprises a checkerboard pattern.

25. A method of recording an audio signal associated with a photograph, the method comprising:

sensing an input image;

recording an associated audio signal;

printing said input image on a first surface of a print media; and

printing an encoded version of said audio signal on a second surface of said print media.

26. A camera system having:

an area image sensor means for sensing an image;

an image storage means for storing the senseD image;

an orientation means for sensing the camera's orientation; and

a processing means for processing said sensed image utilising said sensed camera orientation.

27. A camera system as claimed in Claim 1 wherein said processing comprises processing of orientation specific information within said sensed image;

28. A camera system as claimed in Claim 1 wherein said processing comprises detection of image specific information with the sensed image;

29. A camera system as claimed in Claim 1 wherein said processing includes detection of faces within said image.

30. A camera system as claimed in Claim 1 wherein said processing comprises warping features within said image.

31. A method of processing an image in a digital camera system having an orientation sensor for sensing a camera orientation of the sensed image, said method comprising the steps of;

(a) rotating the image in accordance with said current orientation; and

(b) applying an image orientation dependant transform to said rotated image to produce a transformed rotated image.

32. A method as claimed in Claim 6 wherein said image dependent transform comprises one of placing image depended information at a pre-determined located within said image, detecting faces within said image, warping image dependant portions of said image and placement of information relevant to facial features of animals or humans appearing within the image.

33. In an instant image printing camera, which utilises an ink jet type print-head, providing a disposable print roll having a receptacle for the collection of excess waste ink from the printing process.

34. A print roll as claimed in claim 33 wherein the collection means comprises a sponge-like strip affixed to a leaf portion of said print roll.

35. A method of processing a digital image comprising:

capturing the image utilising an adjustable focusing technique;

utilising the focusing settings as an indicator of the position of structures within the image; and

processing the image, utilising the said focus settings to produce effects specific to said focus settings.

36. A method as claimed in claim 35 further comprising the step of:

capturing said image utilising a zooming technique; and

utilising zooming settings in a heuristic manner so as to process portions of said image.

37. A method as claimed in claim 35 wherein said processing step comprises utilising said auto focus

information to assist in the location of objects within the image.

38. A method as claimed in claim 35 wherein said focus setting is derived from a CCD captured digital image a CCD captured digital image.

39. A method of processing an image taken with a digital camera including an eye position sensing means said method comprising the step of utilizing the eye position information within the sensed image to process the image in a spatially varying sense, depending upon said location information.

40. A method as claimed in claim 39 wherein said utilizing step comprises utilizing the eye position information to locate an area of interest within said sensed image

41. A method as claimed in claim 39 wherein said processing includes the placement of speech bubbles within said image.

42. A method as claimed in claim 39 wherein said processing includes applying a region specific warp to said image.

43. A method as claimed in claim 39 wherein said processing includes applying a brush stroke filter to the image having greater detail in the area of said eye position information.

44. A method as claimed in any of claims 39 to 43 wherein said digital camera includes means for substantially immediately printing out the results of said processing step.

45. A method of processing an image taken with a digital camera including an auto exposure setting, said method comprising the step of utilising said information to process a sensed image.

46. A method as claimed in claim 45 wherein said utilising step comprises utilising the said auto exposure setting to determine an advantageous re-mapping of colours within said image so as to produce an amended image having colours within an image transformed to account of said auto exposure setting.

47. A method as claimed in claim 46 wherein said processing comprises re-mapping image colours so they appear deeper and richer when said exposure setting indicates low light conditions.

48. A method as claimed in claim 47 wherein said processing step comprises re-mapping image colours to be brighter and more saturated when said auto exposure setting indicates bright light conditions.

49. A method as claimed in claim 45 wherein said utilising step includes adding exposure specific graphics or manipulations to said image.

50. A method of processing an image captured utilising a digital camera and a flash said method comprising the steps of :

a) locating distortions of said captured image due to the utilisation of said flash;

b) retouching said image so as to locally reduce the effect of said distortions.

51. A method as claimed in Claim 1 wherein said locating step comprises automatically locating faces within an image.

52. A method as claimed in Claim 1 where it said distortions include "red-eye" effects;

53. A digital camera having reduced flash distortion effects on captured images comprising;

(a) a digital means capturing image for the capture of images;

(b) a distortion location means for locating flash induced colour distortions in the captured image; and

(c) image inversed distortion means connected to said distortion location means and said digital image capture means and adapted to process said captured image to reduce the effects of said distortions;

(d) display means connected to said distortion for displaying.

54. A method of processing an image captured utilising a digital camera and a flash said method comprising the step of applying flash setting specific graphics or manipulations to said image.

55. A camera system which provides for the instant printing of images, the utilisation of a print-head for printing relevant information on the back of each image printed out.

56. In a camera system for providing instant images on demand and having an internal print roll, providing a series of anti-curling rollers to de-curl print media exiting from the print roll.

57. A method of creating a stereoscopic photographic image comprising:

(a) utilising a camera device to image a scene stereographically;

(b) printing said stereographic image as an integrally formed image at predetermined positions on a first surface portion of a transparent printing media, said transparent printing media having a second surface including a lensing system so as to stereographically image said scene to the left and right eye of a viewer of said printed stereographic image.

58. A print media and ink supply means adapted to supply a printing mechanism with ink and printing media upon which the ink is to be deposited, said media and ink supply means including a roll of media rolled upon a media former within said media and ink supply means and at least one ink reservoir integrally formed within said media and ink supply means and adapted to be connected to said printing mechanism for the supply of ink and printing media to said printing mechanism.

59. A media and ink supply means as claimed in claim 58 wherein said means is detachably mounted to said printing mechanism.

60. A media and ink supply means as claimed in claim 58 wherein said printing mechanism includes a camera for the production of images.

61. A media and ink printing means as claimed in claim 60 wherein said camera is a portable, hand held camera device.

62. A media and ink supply means as claimed in claim 58 wherein the number of ink reservoirs is sufficient to produce full colour images.

63. A media and ink supply means as claimed in claim 62 wherein said ink reservoirs included a cyan ink reservoir, yellow ink reservoir and a magenta ink reservoir.

64. A media and ink supply means as claimed in claim 58 wherein said media comprises one of the group of plastic opaque material, transparent material, metallic surfaced material or fabric.

65. A media and ink supply means as claimed in claim 58 wherein said ink reservoir is mounted within said media former and said media former is adapted to rotate around at least one ink reservoir.

66. A media and ink supply means as claimed in claim 62 wherein each of the said ink reservoirs includes a corresponding ink channel connecting said reservoir to an external port on said media and ink supply means and said media and ink supply means includes an external port for each of the said reservoirs.

67. A media and ink supply means as claimed in claim 58 wherein said ink reservoirs include a collapsible membrane adapted to collapse upon utilisation of the ink within said ink reservoir.

68. A media and ink supply means as claimed in claim 58 wherein said ink reservoir is sealed within a pressure controlled environment.

69. A media and ink supply means as claimed in claim 68 wherein said pressure controlled environment is in pressure communication with an external port on the said media and ink supply means utilised for the control of said pressure of said ink.

70. A media and ink supply means as claimed in claim 58 further including a surface having a cavity defined therein adapted to allow the insertion of an integrated circuit device having a plurality of communication leads attached thereto, said integrated circuit device being utilised for storage of characteristics and information relating to said media and ink.

71. A media and ink supply means as claimed in claim 60 wherein said media and ink supply means is adapted to be extracted from and inserted into said portable camera.

72. A media and ink supply means as claimed in claim 58 wherein said means includes a cover having a single slot defined therein through which said media exits from said media and ink supply means.

73. A transparent print media comprising a first surface having a plurality of lenticular portions adapted to image left and right stereo images printed on an opposing surface to said first surface so as to produce a stereo photographic image when viewed from said first surface.

74. A transparent print media as claimed in claim 73, wherein said lenticular lenses are of a part cylindrical form across a first axis of said images.

75. A transparent print media as claimed in claim 73, wherein said print media forms a part of a print media and ink supply means adapted to supply a printing mechanism with ink and said transparent print media upon which the ink is to be deposited, said media and ink supply means including a roll of said transparent print media rolled upon a media former in said media and ink supply means and at least one ink reservoir integrally formed within said media and ink supply means and adapted to be connected to said printing mechanism for the supply of ink and transparent printing media to said printing mechanism.

76. A transparent print media as claimed in claim 73, wherein said transparent media is utilised in a camera device to image a scene in a stereographic format.

77. A print media as claimed in claim 76 wherein said camera device further includes means for determining a current position of said lenticular lenses within said camera device.

78. A print roll for use in a camera imaging system said print roll having a backing surface having a plurality of formatted postcard information printed at pre-determined intervals.

79. A print roll as claimed in claim 78 wherein said formatted postcard information includes postage.

80. A print roll as claimed in claim 78 wherein on the external surface of said print roll there is printed information detailing the postage and/or format of postcards contained within the print roll.

81. A print roll as claimed in claim 80 wherein said printed information includes countries that postcards produced by said camera imaging system are suitable to be utilised in.

82. A print roll as claimed in claim 80 wherein said printed information includes an expiry date beyond which the postage is no longer guaranteed to be valid.

83. A method of creating customised postcards comprising the steps of:

utilising a camera device having a print roll having a backing surface including a plurality of formatted

postcard information sections at pre-determined positions on said backing surface;

imaging a customised image on a corresponding imaging surface of said print roll; and

utilising said print roll to produce postcards via said camera device.

84. A method of sending postcards comprising camera images through the postal system said method comprising steps of:

selling a print roll having prepaid postage contained within the print roll;

utilising the print roll in a camera imaging system to produce postcards having prepaid postage; and

sending said prepaid postcards through the mail.

85. A method is claimed in claim 84 wherein on the external surface of the said print roll there is printed at least one of the costs of the prepaid postage for each postcard; the countries with which postcards printed out utilising the print roll will be suitable to send to: or an expiry date after which postcards sent through the postal system are no longer guaranteed to have adequate postage.

86. A print roll for use in an imaging device said print roll including imaging media and ink, said roll further including an integral integrated circuit device having an on board storage area containing device characteristics of the print media and/or the ink.

87. A print roll as claimed in claim 86 wherein said ink is located internally of said imaging media and said roll further contains a cavity within which is located said integrated circuit device.

88. A print roll as claimed in claim 86 wherein said integrated circuit device is located within a epoxy resin having a number of external leads connected to the exterior surface of said epoxy.

89. A print roll as claimed in claim 86 wherein the number of leads is less than or equal to 4.

90. A print roll as claimed in claim 86 wherein said roll is designed to be inserted in a portable camera device and said integrated circuit interconnects with the electronics of said portable camera device.

91. A print roll as claimed in claim 86 wherein said connection comprises the interconnections of said leads with corresponding raised abutments on a protrusion inside the camera device.

92. A print roll as claimed in claim 86 wherein said storage area comprises flash memory storage.

93. A print roll as claimed in claim 86 wherein said characteristics include parameters used to adjust a printing device in said corresponding camera.

94. A print roll as claimed in claim 86 wherein said parameters include at least one of the ink viscosity, the ink colour, the print media or the ideal drop volume size.

95. A camera utilising a print roll as claimed in claim 86 wherein said parameters are utilised to alter the ink ejection characteristics of a printer located within said camera.

96. A print roll as claimed in claim 86 wherein said storage area includes an extended bit pattern storage area for storing an extended code.

97. A print roll for location within a portable imaging device said print roll including an integrated circuit including authorisation means located within said integrated circuit, said camera device utilising said authorisation means to determine if said print roll is of a predetermined standard.

98. A print roll as claimed in claim 97 wherein said authorisation means includes a tamper, access proof authorisation number.

99. A print roll as claimed in claim 97 wherein said print roll is adapted to be interrogated by said

camera by means of the submission of a number and said print roll responds to said interrogation by returning an expected corresponding response.

100. A print roll as claimed in claim 97 wherein said camera includes a further copy of said authorisation means and is adapted to compare responses received from said print roll and its own copy of said authorisation means so as to determine if said print roll is a valid print roll.

101. A plane print media having a reduced degree of curling in use, said print media having anisotropic stiffness in the direction of said planes.

102. A plane print media as claimed in claim 101 wherein said media is stored in a roll and the greatest stiffness strength is substantially in the direction of the axis of said roll.

103. A plane print media as claimed in claim 101 wherein said anisotropic stiffness is achieved by means of a substantially periodic variation in the stiffness strength of the weaker anisotropic axis.

104. A plane print media as claimed in claim 101 wherein said print media includes a plurality of regularly spaced ribs running in the strongest anisotropic axis.

105. A plane print media as claimed in claim 104 wherein said ribs are formed by pinching a substantially flat form of said plane media by a corrugated roller.

106. A plane print media as claimed in claim 101 wherein said media is formed by means of extrusion.

107. A plane print media as claimed in claim 103 wherein said media is formed from the fusion of a plurality of substantially parallel supporting fibres with a image carrying sheet.

108. A plane print media as claimed in claim 107 wherein said fibres are formed from the extrusion of a fiberous supporting material.

109. A plane print media as claimed in claim 107 wherein said fibre material comprises polyethylene naphthalate.

110. A plane print media as claimed in claim 102 wherein said roll is utilised in a hand held camera type device for the printing of images on said print media.

111. A method of reducing the curl in an image printed on plane print media having an anisotropic stiffness said method comprising applying a localised pressure to a portion of said print media.

112. A method as claimed in claim 111 wherein said plane print media has a long axis and a short axis anisotropic stiffness is greatest substantially in the said short axis.

113. A plane print media as claimed in claim 103 wherein the period of said periodic variation is substantially 200 microns.

114. A print roll including an integrated circuit device measuring the amount of consumable materials left within said print roll.

115. A camera device able to operate in a number of different modes, each of said modes having different output format requirements, said camera device containing and including an indicator of the number of pictures left depending on the output format.

116. A camera device as claimed in claim 115 wherein said output formats are one of the group C H or P output format.

117. A camera device as claimed in claim 115 wherein said camera includes means for selection between said three modes of C H and P.

118. A camera device as claimed in claim 115 wherein said camera device updates said integrated circuit device to reflect a new amount of consumables left upon taking a picture.

119. A method of automatically processing an image comprising locating within the image features having a high spatial variance and stroking the image with a series of brush strokes emanating from those areas having high spatial variance.

120. A method as claimed in claim 119 wherein said brush stroke have decreasing sizes near important features of the image.

121. A method as claimed in claim 119 wherein said brush strokes include opacity and bump maps for added realism.

122. A method as claimed in claim 119 wherein the position of a predetermined portion of brush strokes undergoes random jittering.

123. A method of warping of producing a warped image from an input image, said method comprising the steps of:

inputting a warp map for an arbitrary output image having predetermined dimensions A x B, each element of said warp map mapping a corresponding region in a theoretical input image to a pixel location of said arbitrary output image corresponding to theco- ordinate location of said element within said warp map;

scaling said warp map to the dimensions of said warped image so as to produce a scaled warp map;

for substantially each element in said scaled warp map, calculating a contribution region in said input image through utilization of said element value and adjacent element values; and

determining an output image colour for a pixel of said warped image corresponding to said element from said contribution region.

124. A method as claimed in claim 123 wherein said input image is stored in the form of an image pyramid and said determining step comprises interpolating between levels of said image pyramid.

125. A method as claimed in any of claims 123 to 124 wherein said warp map is stored in independent dimensional co-ordinates as separate channels.

126. A method as claimed in any of claims 123 to 125 wherein said contribution region is calculated utilising a maximum span between adjacent elements in said scaled warp map.

127. A method as claimed in claim 124 wherein said interpolation between levels comprises linear interpolation.

128. A method as claimed in any of claims 123 to 127 wherein said method is utilised in a hand held camera to warp sensed images on demand for immediate output of a warped version of said image.

129. A method as claimed in claim 128 wherein said warp map is input separately on detachable storage media into said camera.

130. A method as claimed in claim 129 wherein said detachable storage media comprises a card.

131. A method as claimed in any of claims 123 to 130 wherein said scaled warp map is produced through bilinear interpolation of said warp map.

132. A warping system for warping input images so as to produce corresponding warped output image said warping system comprising:

image input means for inputting an input image into said warping system

warp map input means for inputting a warp map consisting of an array of values mapping an arbitrary region in said input image to said array location;

means for scaling said warp map to the dimensions of an output image;

means for determining a corresponding region in said input image of each pixel in said output image via said warp map;

means for determining and outputting a colour from said corresponding region.

133. A method for automatically detecting a region of interest in an image for manipulation in a handheld camera device, said method comprising the steps of:

converting the image to a suitable colour space

inputting a series of seed values, each seed value having a seed colour range, a local colour difference limit and a global colour difference limit;

for each seed value, determining an output regions by determining those adjacent pixels that differ by no more than the local colour difference limit and differ from the seed colour by no more than the global colour difference.

134. A method of converting an input image to a tiled output image, said method comprising the steps of:

defining at least one tile which, together form a tile pattern unit for tiling the output image;

tiling said image utilizing said tile pattern unit to produce a tiled output image.

135. A method as claimed in claim 134 wherein said tiles include associated shape and opacity channel information.

136. A method as claimed in claim 135 wherein said tiles are composited with said output image according to a tile's opacity channel.

137. A method as claimed in any of claims 134 to 136 wherein said tiles further include associated texture channel information.

138. A method as claimed in any of claims 134 to 137 wherein said output image further includes a global overall opacity and said tile opacity channel is combined with said global overall opacity.

139. A method as claimed in any of claims 134 to 138 wherein the overall opacity of a tile is derived as a single value from said opacity channel information.

140. A method as claimed in any of claims 134 to 139 wherein said tiles are shaped substantially as brush strokes.

141. A method as claimed in any of claims 134 to 140 wherein said tiles are chosen at random to tile said image.

142. A method as claimed in any of claims 134 to 141 wherein said tiles are utilized to tile said output image in multiple passes of smaller tile size.

143. A method as claimed in any of claims 134 to 142 wherein said tiles are combined with the output image in a highly non-linear way so as to introduce stroke texturing effects into said output image.

144. A method as claimed in any of claims 134 to 143 wherein said tiles are randomly jittered in their output positions.

145. A method as claimed in any of claims 134 to 144 wherein said tiles are formed from a limited set of

colors.

146. A method as claimed in claim 145 wherein said colors are further jittered.

147. A method as claimed in claim 145 wherein the chrominance color of a tile is randomly inverted.

148. A method as claimed in claim 139 wherein said opacity is thresholded to substantially 0 or 100 percent.

149. A method of creating an output image rendering of an arbitrary input image on a computer system, said output image being made up of brush strokes, said method comprising the steps of:

defining an initial palette of paint colors;

defining a set of brush strokes;

defining a canvas onto which to render the output image; and

creating said output image on said canvas utilizing said brush strokes colored from said palette.

150. A method as claimed in claim 149 wherein said brush strokes include an associated opacity and bump map.

151. A method as claimed in claim 149 wherein said creating step includes creating a table of stroke color palettes indexed by brush stroke, comprising for each brush stroke in the brush stroke set, and for each color in the paint palette:

coloring the brush stroke with the paint color;

compositing the brush stroke with an empty canvas;

compute the average color across the painted stroke;

utilizing the average color in the appropriate stroke color palette, indexed by the brush stroke;

152. A method as claimed in claim 151 further comprising finding the nearest stroke color in the stroke color palette and utilizing its corresponding paint color in the paint color for the brush stroke.

153. A method as claimed in claim 152 further comprising diffusing the difference between the desired paint color and the selected paint color to surrounding parts of the input or output image.

154. A method as claimed in claim 149 wherein said brush strokes include multi-coloured brush strokes.

155. A method of increasing the resilience of data stored on a media for reading by a sensor device pricing the steps of:

(a) modulating the stored data in a recoverable fashion with the modulating signal having a high frequency component.

(b) storing the data on said medium in a modulated form;

(c) sensing the modulated stored data by said sensor device;

(d) neutralising the modulation of the modulated stored data to track the spread of location of said modulated stored data on said medium; and

(e) recovering the unmodulated stored data from the modulated stored data.

156. A method is claimed in claim 155 wherein said modulating signal comprises a two dimensional check board pattern.

157. A method is claimed in claim 156 wherein said modulating comprises exclusive ORing said pattern with said data.

158. A method is claimed in claim 155 wherein said media comprises a printed surface.

159. A method is claimed in claim 158 wherein said printed surface is substantially of a credit card size.

160. A method is claimed in claim 155 wherein said media further includes data clocking information having a frequency component substantially the same as said modulating signal.

161. A method is claimed in claim 155 wherein said media includes clocking information.

162. A method is claimed in claim 155 wherein said clocking information is located along the borders of said storage medium.

163. A method is claimed in claim 162 wherein said media further includes clocking information along an internal surface said medium.

164. A card for the storage of data said card having on at least one surface thereof printed said data modulated with a high frequency signal.

165. An apparatus as claimed in claim 164 wherein said high frequency component comprises a chec k board pattern.

166. A method of converting a scanned image comprising scanned pixels to a corresponding bitmap image, said method comprising the steps of, for each bit in the bitmap image;

a. determining an expected location in said scanned image of a current bit from the location of surrounding bits in said scanned image;

b. determining a likely value of said bit from the values at the locations of expected corresponding pixels in said scanned image;

c. determining a centroid measures of the centre of the centre of the expected intensity at the said expected location;

d. determining similar centroid measures for adjacent pixels surrounding said current bit in said scanned image and;

e. where said centroid measure is improved relative to said expected location, adjusting said expected location to be an adjacent pixel having an improved centroid measure.

167. An apparatus for text editing an image comprising:

a digital camera device able to sense an image;

a manipulation data entry card adapted to be inserted into said digital camera device and to provide manipulation instructions to said digital camera device for manipulating said image, said manipulation instructions including the addition of text to said image; and

a text entry device connected to said digital camera device for the entry of said text for addition to said image wherein said text entry device includes a series of non-roman font characters utilised by said digital camera device in conjunction with said manipulation instructions so as to create new text characters for addition to said image;

168. An apparatus as claimed claim 167 wherein the font characters are transmitted to said digital camera device when required and rendered by said apparatus in accordance with said manipulation instructions so as to create said new text characters.

169. An apparatus as claimed in claim 167 wherein said manipulation data entry card includes a rendered roman font character set.

170. An apparatus as claimed in claim 167 wherein said non-roman characters include at least one of Hebrew, Cyrillic, Arabic, Kanji or Chinese characters.

171. An apparatus as claimed in claim 167 wherein said series of non-roman character fonts include path outlines for each font character.

172. An apparatus as claimed in claim 167 wherein said series of non-roman character fonts include path outlines for each font character.

173. An apparatus for text editing an image comprising:

a digital camera device able to sense an image;

a manipulation data entry card adapted to be inserted into said digital camera device and to provide manipulation instructions to said digital camera device for manipulating said image, said manipulation instructions including the addition of text to said image; and

a text entry device connected to said digital camera device for the entry of said text for addition to said image wherein said text entry device includes a series of non-roman font characters utilised by said digital camera device in conjunction with said manipulation instructions so as to create new text characters for addition to said image;

174. An apparatus as claimed claim 173 wherein the font characters are transmitted to said digital camera device when required and rendered by said apparatus in accordance with said manipulation instructions so as to create said new text characters.

175. An apparatus as claimed in claim 173 wherein said manipulation data entry card includes a rendered roman font character set.

176. An apparatus as claimed in claim 173 wherein said non-roman characters include at least one of Hebrew, Cyrillic, Arabic, Kanji or Chinese characters.

177. An apparatus as claimed in claim 173 wherein said series of non-roman character fonts include path outlines for each font character.

178. An apparatus as claimed in claim 173 wherein said series of non-roman character fonts include path outlines for each font character.

179. A portable camera with integral printer device, said camera including:

(a) a digital image capture device for the capturing of digital images;

(b) an integral programming language interpreter means connected to said digital image capture means for the manipulation of said digital image;

(c) a script input means for inputting a program script for the manipulation of said digital image;

herein said script is executed by said interpreter means so as to modify said image in accordance with said script so to provide a printout of a modified image on said integral printer.

180. A portable camera as claimed in claim 179 wherein said script input means comprises a script stored on a card and a card reader for the reading of said scripts from said card.

181. A portable camera as claimed in claim 180 where it said cards have, on one surface, an encoded form of the said script and, on a second surface, have an example of the likely effect of said script on an image.

182. A portable camera claimed in claim 179 where said programming language includes language constructs for the implementation of at least one of image warping, convolution, color lookup tables, posterizing images, adding noises to images, image enhancement, image painting algorithms including brush jittering and tiling, edge detection, image illumination, text and fonts, face detection, and the utilization of arbitrary complexity pre-rendered graphical objects.

183. An image copying device for reproduction of an input image which comprises a series of ink dots, said device comprising:

(a) imaging array means for imaging said input image at a sampling rate higher than the frequency of said dots so as to produce a corresponding sampled image;

(b) processing means for processing said image so as to determine the location of said print dots in said sample image;

(c) print means for printing ink dots on print media at locations corresponding to the locations of said print dots.

184. An image copying device as claimed in claim 183 wherein said copying device prints a full color copies of said input image.

185. A camera system for outputting deblurred images, said system comprising:

an image sensor for sensing an image;

a velocity detection means for determining any motion of said image relative to an external environment and to produce a velocity output indicative thereof;

a processor means interconnected to said image sensor and said velocity detection means and adapted to process said sensed image utilising the velocity output so as to deblurr said image and to output said deblurred image.

186. A camera system as claimed in claim 185 wherein said processor means is connected to a printer means for immediate output of said deblurred image.

187. A camera system as claimed in claim 185 wherein said camera system is a portable handheld camera device.

188. A camera system as claimed in claim 185 wherein said velocity detection means comprises an accelerometer.

189. A camera system as claimed in claim 188 wherein said accelerometer comprises a mircro-electro mechanical device.

190. A photosensor reader preform comprising:

(a) a series of light emitter recesses for the insertion of light emitted devices;

(b) light emitter focusing means for focusing light emitted from the series of light emitter devices onto the surface of an object to be imaged as it traverses the surface of said preform;

(c) a photosensor recess for the insertion of a linear photosensor array; and

(d) focussing means for focussing light reflected from said object to be imaged onto a distinct portion of said CCD array.

191. A photosensor reader preform as claimed in claim 190 wherein said focussing means comprises a

microlense array for focussing light reflected from said object onto a predetermined portion of said linear photosensor array.

192. A photosensor reader preform as claimed in claim 190 wherein said linear photosensor array comprises a linear CCD array.

193. A photosensor reader preform as claimed in claim 190 wherein said light emitter focussing means comprises a transparent portion of said preformed having a substantially circular circumference.

194. A photosensor reader preform as claimed in claim 190 wherein said object comprises a card having a data encoded thereon.

195. A photosensor reader preform as claimed in any proceeding claim wherein said linear photosensor has a large number of interleaved sensing elements wherein adjacent sensing elements are non-interleaved.

196. A photosensor reader preform as claimed in preceding paragraph wherein the preform is ejection moulded as a single unit.

197. A printer device for interconnection with a computer system comprising:

a printer head unit including an ink jet print head for printing images on print media and further having a cavity therein for insertion of a consumable print roll unit;

a print roll unit containing a roll of consumable print media and ink for insertion into said cavity, said ink being utilised by said ink jet print head for printing images on said print media.

198. A printer device as claimed in claim 197 further comprising a universal service port (USP) for interconnection of said computer system to said printer device.

199. A printer device as claimed in claim 197 wherein said printer head unit includes page width print head for the outputting of images on said printer device.

200. A printer device as claimed in claim 197 wherein said print roll unit has a teardrop cross-section which substantially mates with the cross-section of said cavity.

201. A digital camera system comprising:

a sensing means for sensing an image;

modification means for modifying said sensed image in accordance with modification instructions input into said camera; and

an output means for outputting said modified image;

wherein said modification means includes a series of processing elements arranged around a central crossbar switch.

202. A digital camera as claimed in claim 201 wherein said processing elements include an Arithmetic Logic Unit (ALU) acting under the control of a microcode store wherein said microcode store comprises a writeable control store.

203. digital camera as claimed in any of claims 201 to 202 wherein said processing elements include an internal input and output FIFO for storing pixel data utilized by said processing elements.

204. A digital camera system as claimed in any of claims 201 to 203 wherein said modification means is interconnected to a read and write FIFO for reading and writing pixel data of images to said modification means.

205. A digital camera as claimed in any of claims 201 to 204 wherein said processing elements are arranged in a ring and each element is also separately connected to its nearest neighbours.

206. A digital camera as claimed in any of claims 202 to 205 wherein said ALU accepts a series of inputs interconnected via an internal crossbar switch to a series of core processing units within said ALU.

207. A digital camera as claimed in claim 206 wherein said core processing units include at least one one of a multiplier, an adder and a barrel shifter.

208. A digital camera as claimed in claims 206 or 207 wherein said ALU includes a number of internal registers for the storage of temporary data.

209. A digital camera as claimed in any of claims 201 to 208 wherein said processing elements are further connected to a common data bus for the transfer of pixel data to said processing elements.

210. A digital camera as claimed in claim 209 where said data bus is interconnected to a data cache which acts as an intermediate cache between said processing elements and a memory store for storing said images.

211. A method of rapidly decoding, in real time, sensed image data stored at a high pitch rate on a card, said method comprising the steps of;

detecting the initial position of said image data;

decoding the image data so as to determine a corresponding bit pattern of said image data.

212. A method as claimed in claim 211 wherein said detecting step comprises detecting the location of a predetermined number of targets offset a predetermined amount from said data, determining a line substantially through said series of targets from the positions located thereon; and utilising said line and said location of targets to determine the start of an image data area;

213. A method as claimed in any of claims 211 to 212 wherein said targets comprise a small region of a first colour within a much larger region of second colour distinguishable from said first colour.

214. A method as claimed in claim 213 wherein said small region comprises a single small dot and said larger region comprises a square region having said small region as its center.

5 A method as claimed in any of claims 1 to 3 wherein said method process columns of sensed data at a time and transforming said columns into corresponding runlength encoded versions of said columns.

215. A method as claimed in claim 205 wherein said runlength encoded versions are categorised into three categories of short medium and long runlengths and said categories are utilised in determining the locations of said targets.

216. A method as claimed in any of claims 211 to 215 wherein said method goes to an error state if less than a predetermined number of targets are found.

217. A method as claimed in any of claims 211 to 216 wherein said spaced apart targets are substantially rotational invariant under small rotations of said card.

218. A method of rapidly decoding sensed image data in a fault tolerant manner, said data stored at a high pitch rate on a card and subject to rotations, warping and marking, said method comprising the steps of:

determining an initial location of a start of said image data;

sensing said image data at a sampling rate greater than said pitch rate;

processing said sensed image data in a column by column process, keeping an expected location of the center of each dot (centroid) of a next column and utilising fine adjustments of said centroid when processing each column so as to update the location of an expected next centroid.

219. A method as claimed in claim 218 wherein the centroid location is stored in the form of separate adjustment changes to be made in a vertical and horizontal direction.

220. A method as claimed in claim 219 wherein said adjustment deltas are stored in a differential form.

221. A method as claimed in any of claims 218 to 220 wherein said fine adjustments are only made when an actual centre location of a dot is detected.

222. A method as claimed in any of claims 218 to 221 wherein said sampling rate is greater than twice the pitch frequency of said dots.

223. A method as claimed in any of claims 218 to 222 wherein said sensed image data includes predetermined clocking marks around an external border of said image data.

224. A method as claimed in claim 223 wherein said clock marks include an alternating checkerboard pattern.

225. A method of accurately detecting the value of a dot of sensed image data, said image data comprising an array of dots and said sensed image data comprising a sampling of said image data at a rate greater than the pitch frequency of said array of dots so as to produce an array of pixels, said method comprising the steps of:

determining an expected middle pixel of said array of pixels, said middle pixel corresponding to an expected central location of a corresponding dot;

utilising the sensed value of said middle pixel and the sensed value of a number of adjacent pixels as an index to a lookup table having an output corresponding to the value of a dot centred around the corresponding location of said pixel.

226. A method as claimed in claim 225 further comprising detecting the location of a center of a current dot and utilising the position of said detected location relative to the location of said middle pixel to determine which of said adjacent pixels to utilise in said index to said lookup table.

227. A method of accurately determining the location of dots of sensed image data amongst an array of dots of image data in a fault tolerant manner, said data stored at a high pitch rate on a card and subject to rotations, warping and marking effects, said method comprising the steps of:

processing the image data in a column by column format;

recording the dot pattern of previously processed columns of pixels;

generating an expected dot pattern at a current column position from the recorded dot pattern of previously processed pixels;

comparing the expected dot pattern with an actual dot pattern of sensed image data at said current column position;

if said comparison produces a match within a predetermined error, utilising said current column position as an actual dot position otherwise altering said current column position to produce a better fit to said expected dot pattern to thereby produce new actual dot position, and

utilising said actual dot position of the dot at a current column position in the determining of dot location of

dots of subsequent columns.

228. A method as claimed in claim 227 wherein said actual dot position is stored in the form of a difference between an expected dot position and a recorded actual dot position.

229. A method as claimed in any of claims 227 to 228 wherein said expected dot pattern is derived from previously recorded dot patterns for a current row of said current column position.

230. A method as claimed in claim 229 wherein said sensed image data is supersampled at a rate of substantially three times the dot pitch rate and said expected dot pattern comprises a 20 bit pattern corresponding to the intensities sensed along said current row.

231. A method as claimed in claim 229 wherein said method is repeated for a current column of said current column position.

232. A method as claimed in any of claims 227 to 231 wherein said expected dot position is recorded in the form of differential column and row components.

233. A method of combining image bump maps to simulate the effect of painting on an image, said method comprising:

defining an image canvas bump map approximating the surface to be painted on;

defining a painting bump map of a painting object to be painted on said surface;

combining said image canvas bump map and said painting bump map to produce a final composited bump map utilising a stiffness factor, said stiffness factor determining the degree of modulation of said painting bump map by said image canvas bump map.

234. A method as claimed in claim 233 wherein said combining step comprises low-pass filtering said image canvas bump map to produce a low-pass filtered bump map and said stiffness factor is utilised to determine the degree of low-pass filtering.

235. A method as claimed in claim 233 wherein the height of said bump map is utilised in determining the degree of low-pass filtering.

236. A method as claimed in claim 233 wherein said low-pass filtering includes utilising a filter radius to determine the degree of filtering.

237. A method as claimed in claim 233 wherein said method is utilised in a hand held camera device to produce instant images on demand having a brushed artistic interpretation of a sensed image.

238. A method of automatically manipulating an input image to produce an artistic effect comprising:

predetermining a mapping of an input gamut to a desired output gamut so as to produce a desired artistic effect; and

utilising the mapping to map the input image to an output image having a predetermined output gamut;

239. A method as claimed in claim 238 further comprising the step of post processing the output image utilising a brush stroke filter.

240. A method as claimed in claim 238 wherein the output gamut is formed from mapping a predetermined number of input gamut values to corresponding output colour gamut values and interpolating the remaining mapping of input gamut values to output colour gamut values.

241. A method as claimed in claim 240 wherein the interpolation process includes utilising a weighted

sum of the mapping of a predetermined number of input gamut values to corresponding output colour gamut values.

242. A method of compressing an input colour gamut to be within an output colour gamut, the method comprising the steps of:

determining a zero chrominance value point at a current input colour intensity;

determining a source distance being the distance from the zero chrominance value to the edge of the input colour gamut;

determining a suitable edge of the output colour gamut;

determining a target distance being the distance from the zero chrominance value to the edge of the output colour gamut; and

scaling the current input colour intensity by a factor derived from the ratio of source distance to target distance.

243. A method as claimed in claim 242 wherein the current input colour intensity is further scaled by a factor dependent on the distance for the current input colour from the zero chrominance value point.

244. A handheld camera for the output of an image sensed by said camera, said camera including:

sensing means for sensing an image;

tiling means for adding tiling effects to said sensed image to produce a tiled image; and

display means for displaying said tiled image.

245. A handheld camera as claimed in claim 244 wherein said display device comprises a printer device for printing out immediate photos by said camera.

246. A handheld camera as claimed in any of claims 244 to 245 wherein tiling effect includes tessellating a tile in a vertical and horizontal direction.

247. A handheld camera as claimed in any of claims 244 to 246 wherein said tiling effects are applied only to a portion of said sensed image.

248. A handheld camera as claimed in any of claims 244 to 247 wherein said sensed image has an associated bump map utilized by said tiling means so as to produce 3-dimensional effects as part of said tiling effects.

249. A handheld camera as claimed in any of claims 244 to 248 wherein said tiling effects include opacity effects

250. A handheld camera as claimed in any of claims 244 to 249 wherein said tiling effects include utilisation of feedback from said sensed image.

251. A handheld camera as claimed in any of claims 244 to 250 wherein said tiling effects include texturing of said tiles.

252. A handheld camera as claimed in any of claims 244 to 251 wherein said tiling means is implemented in the form of a microprogrammed series of Arithmetic Logic Units.

253. A method of producing an output image for a handheld camera said method comprising the steps of:

sensing an input image;

manipulating said input image so as to simulated the effects of tiling said image;

outputting said image on a display device connected to said camera.

254. A method as claimed in claim 252 wherein said display device comprises a printer device for

printing out immediate photos by said camera.

255. A method as claimed in claims 252 or 253 wherein said tiling effects are determined by a card containing encoded information inserted into said camera.

256. A handheld camera for the output of an image sensed by said camera, said camera including:

sensing means for sensing an image;

texture mapping means for adding texturing effects to said sensed image to produce a textured image; and

display means for displaying said textured image.

257. A handheld camera as claimed in claim 256 wherein said display device comprises a printer device for printing out immediate photos by said camera.

258. A handheld camera as claimed in any of claims 256 to 257 wherein said sensed image has an associated bump map utilized by said texture means so as to produce 3-dimensional effects as part of said texture effects.

259. A handheld camera as claimed in any of claims 256 to 258 wherein said texture means is implemented in the form of a microprogrammed series of Arithmetic Logic Units.

260. A method of producing an output image for a handheld camera said method comprising the steps of:

sensing an input image;

manipulating said input image so as to simulated the effects of texturing of said image;

outputting said image on a display device connected to said camera.

261. A method as claimed in claim 260 wherein said display device comprises a printer device for printing out immediate photos by said camera.

262. A method as claimed in claims 260 or 261 wherein said texturing effects are determined by a card containing encoded information inserted into said camera.

263. A handheld camera for the output of an image sensed by said camera:

said camera including sensing means for sensing an image;

lighting means for adding lighting to said sensed image to produce an illuminated image which simulates the effect of light sources projected at said sensed image; and

display means for displaying said illuminated image.

264. A handheld camera as claimed in claim 263 wherein said display device comprises a printer device for printing out immediate photos by said camera.

265. A handheld camera as claimed in any of claims 263 to 264 wherein said light sources include directional, omni or spot lights.

266. A handheld camera as claimed in any of claims 263 to 265 wherein said sensed image forms only part of said illuminated image.

267. A handheld camera as claimed in any of claims 263 to 266 wherein said sensed image has an associated bump map utilised by said lighting means so as to produce 3-dimensional effects as part of said lighting effects.

268. A handheld camera as claimed in any of claims 263 to 267 wherein said lighting means is implemented in the form of a micro-programmed series of Arithmetic Logic Units.

269. A handheld camera as claimed in any of claims 263 to 268 wherein said lighting effects include attenuations of said light sources.

270. A handheld camera as claimed in any of claims 263 to 269 wherein said lighting effects include diffuse contributions of said light sources.

271. A method of producing an output image for a handheld camera said method comprising the steps of:

sensing an input image;

manipulating said input image so as to simulate the effects of lighting sources placed and predetermined locations around said image;

outputting said image on a display device connected to said camera.

272. A method as claimed in claim 271 wherein said display device comprises a printer device for printing out immediate photos by said camera.

273. A method as claimed in claims 271 or 272 wherein said lighting effects are determined by a card containing encoded information inserted into said camera.

274. A garment creation system comprising:

a series of input tokens for inputting to a camera device for manipulation of a sensed image for outputting on a display device depicting a garment constructed of fabric having characteristics of said sensed image;

a camera device adapted to read said input tokens and sense an image and manipulate said image in accordance with a read input token so as to produce said output image; and a display device adapted to display said output image.

275. A garment creation system as claimed in claim 274 wherein said display device comprises a printer.

276. A garment creation system as claimed in claim 274 wherein said input tokens comprise cards.

277. A garment creation system as claimed in claim 276 wherein said cards, have on one surface thereof, a depiction of the garment to be created by said input token.

278. A garment creation system as claimed in claim 274 wherein said input tokens are distributed in collections applying similar manipulations to a different series of garments.

279. A garment creation system as claimed in claim 274 wherein said input tokens are distributed in collections applying different manipulations to the same item of apparel

280. A garment creation system comprising:

an expected image creation system including an image sensor device and an image display device, said image creation system mapping portions of an arbitrary image sensed by said image sensor device onto a garment and outputting on said display device a depiction of said garment;

a garment fabric printer adapted to be interconnected to said image creation system for printing out corresponding pieces of said garment including said mapped portions.

281. A garment creation system as claimed in claim 280 wherein said garment fabric printer prints out instructions for joining said pieces together on said fabric.

282. A garment creation system as claimed in claim 280 wherein said garment fabric printer prints out instructions for joining said pieces together on said fabric.

283. A garment creation system as claimed in claim 280 wherein said garment fabric printer prints said pieces so that the image, printed on said pieces, appear to be derived from a continuous pattern.

284. A method of creating a manipulated image comprising:

interconnecting a series of camera manipulation units, each of said camera manipulation unit applying an image manipulation to an inputted image so as to produce a manipulated output image, an initial one of said camera manipulation units sensing an image from an environment and at least a final one of said camera manipulation units producing a permanent output image.

285. A method as claimed in claim 284 wherein said camera manipulation units further comprise detachable manipulation instruction media for inputting said manipulation instructions to said corresponding camera manipulation unit;

286. A method as claimed in claim 285 wherein said detachable manipulation instruction media comprises a card.

287. A method as claimed in claim 285 wherein on one surface of said detachable manipulation instruction media is included a visual indication of the result of the manipulation by said manipulation instructions.

288. A method as claimed in claim 284 wherein the output of one of said camera manipulation units is connected to at least two other camera manipulation units.

289. A portable imaging system for viewing distant objects comprising:

(a) an optical lensing system for magnifying a viewed distant object;

(b) a sensing system for simultaneously sensing said viewed distant object;

(c) a processor means interconnected to said sensing system for processing said sensed image and forwarding it to a printer mechanism; and

(d) a printer mechanism connected to said processor means for printing out on print media said sensed image on demand by said portable imaging system.

290. A portable imaging system as claimed in claim 289 further comprising:

(e) a detachable print media supply means provided in a detachable module for interconnection with said printer mechanism for the supply of print media to said printer mechanism.

291. A portable imaging system as claimed in claim 290 wherein said detachable module further includes an integral ink supply adapted to be interconnected with said printer mechanism upon attachment of said detachable print media supply means to said portable imaging system.

292. A portable imaging system as claimed in claim 290 wherein said print media is supplied in a roll form.

293. A portable imaging system as claimed in claim 289 wherein said printer mechanism comprises an ink jet printing mechanism.

294. A portable imaging system as claimed in claim 289 wherein said printer mechanism is a full color printer mechanism.

295. A portable imaging system as claimed in claim 289 wherein said optical lensing system comprise binoculars.

296. A portable imaging system as claimed in claim 289 wherein said optical lensing system includes a beam splitting device which projects said distant object onto said sensing system.

297. A system for playing prerecorded audio encoded in a fault tolerant manner as a series of dots printed on a card comprising:

an optical scanner means for scanning the visual form of said prerecorded audio;

a processor means interconnected to said optical scanner means for decoding said scanned audio encoding to produce a corresponding audio signal; and

audio emitter means interconnected to said processor means for emitting or playing said corresponding audio signal on demand.

298. A system as claimed in claim 297 wherein said audio encoding includes Reed-Solomon encoding of said prerecorded audio.

299. A system as claimed in claim 297 wherein said encoding comprises an array of ink dots.

300. A system as claimed in claim 297 wherein said system includes a wand-like arm having a slot through which is inserted said card.

301. A system as claimed in claim 297 wherein said encoding includes high-frequency modulation of said series of dots.

302. A method of decoding a prerecorded audio signal printed in a faulted tolerant encoded form on a first surface of a card with an image printed on a second surface of said card, said method comprising the steps of:

(a) scanning the encoded form of said card;

(b) decoding said encoded audio signal; and

(c) playing said audio signal on an audio output device.

303. A method as claimed in claim 302 wherein said audio signal is Reed-Solomon encoded by an array of dots on the surface of said card.

304. A method as claimed in claim 302 wherein said encoded form includes modulating an array of dots with a high frequency signal component.

305. A method of information distribution on printed cards said method comprising the steps of:

dividing the surface of the card into a number of predetermined areas;

printing a first collection of data to be stored in a first one of said predetermined areas;

utilising said printed first predetermined area when reading information stored on said card;

and when the information stored on the card is to be updated, determining a second one of said predetermined areas to print further information stored on said card, said second area not having being previously utilized to print data.

306. A method as claimed in claim 305 wherein said predetermined areas are selected in a predetermined order.

307. A method as claimed in claim 305 wherein said printing utilizes a high resolution ink dot printer.

308. A method as claimed in claim 305 wherein said collection of data is printed in an encoded form having a degree of fault tolerance.

309. A method as claimed in claim 305 wherein said collection of data is printed in a Reed-Solomon encoded form.

310. A method as claimed in claim 305 wherein said collection of data is replicated in a chosen

predetermined area.

311. A method as claimed in claim 305 wherein each of said predetermined areas includes a printed border region delineating the border of said area.

312. A method as claimed in claim 305 wherein each of said predetermined areas includes a number of border target markers indicating the location of said region.

313. A method as claimed in claim 312 wherein said boarder regions are utilised when reading information stored on the card to locate the region.

314. A method as claimed in claim 312 wherein said border targets comprise a large area of a first colour with a small region of a second colour located centrally in said first area.

315. A method as claimed in claim 305 wherein said data is printed utilising a high frequency modulating signal.

316. A method as claimed in claim 315 wherein said modulation comprises a checkerboard pattern.

317. A method as claimed in claim 305 wherein said predetermined areas are arranged in a regular array on the surface of said card.

318. A method as claimed in claim 305 wherein said data is stored as an array of dots having a resolution of greater then substantially 1200 dots per inch.

319. A method as claimed in claim 305 wherein said card is of a generally rectangular credit card sized shape.

320. A method of creating a set of instructions for the manipulation of an image, said method comprising the steps of:

(a) displaying an initial array of sample images for a user to select from;

(b) accepting a user's selection of at least one of said sample images;

(c) utilizing attributes of the images of said selection to produce a further array of sample images;

(d) iteratively applying steps (a) to (c) until such time as said user selects at least one final suitable image;

(e) utilising the steps used in the creation of said sample image as said set of instructions;

(f) outputting said set of instructions.

321. A method as claimed in claim 320 further comprising the step of scanning a User's photograph and utilising said scanned photograph as an initial image in the creation of each of said sample images.

322. A method as claimed in claim 320 further comprising the step of printing out said instructions in an encoded form for subsequent utilization by said user.

323. A method as claimed in claim 322 wherein said instructions are printed out in an encoded form on one surface of a card in addition to printing out a visual representation of said instructions on a second surface of said card.

324. A method as claimed in claim 320 wherein said step (c) of utilizing attributes of the images utilizes genetic algorithm or programming techniques to create said array.

325. A method as claimed in claim 320 further comprising the step of saving a series of selected images and utilizing said saved series in said production of a further array of images.

326. An apparatus when implementing the method in accordance with any of claims 320 to 325 above.

327. An apparatus as claimed in 7 wherein said apparatus is in the form of a vending machine.

328. An information storage apparatus for storing information on inserted cards said apparatus comprising:

sensing means for sensing printed patterns on the surface stored on said card, said patterns arranged in a predetermined number of possible active areas of said card;

decoding means for decoding said sensed printed patterns into corresponding data;

printing means for printing dot patterns on said card in at least one of said active areas;

positioning means for positioning said sensed card at known locations relative to said sensing means and said printing means;

wherein said sensing means is adapted to sense the printed patterns in a current active printed area of said card, said decoding means is adapted to decode said sensed printed patterns into corresponding current data and, when said current data requires updating, said printing means is adapted to print said updated current data at a new one of said active areas after activation of said positioning means for correctly position said card.

329. An apparatus as claimed in claim 328 wherein said printing means comprises an ink jet printer device.

330. An apparatus as claimed in claim 328 wherein said ink jet printer includes a card width print head able to print a line width of said card at a time.

331. An apparatus as claimed in claim 329 wherein said positioning means comprises a series of pinch rollers to pinch said card and control the movement of said card.

332. An apparatus as claimed in claim 328 wherein said printed patterns are laid out in a fault tolerant manner and said decoding means includes a decoder for said fault tolerant pattern.

333. An apparatus as claimed in claim 332 wherein said fault tolerant manner comprises Reed - Solomon encoding of said patterns and said decoding means includes a Reed - Solomon Decoder.

334. In a digital camera system comprising:

an image sensor for sensing an image;

storage means for storing said sensed image and associated system structures;

data input means for the insertion of an image modification data module for modification of said sensed image;

processor means interconnected to said image sensor, said storage means and said data input means for the control of said camera system in addition to the manipulation of said sensed image;

printer means for printing out said sensed image on demand on print media supplied to said printer means;

a method of providing an image modification data module adapted to cause said processor means to modify the operation of said digital camera system upon the insertion of further image modification modules.

335. A method as claimed in claim 334 wherein said image modification module comprises a card having said data encoded on the surface thereof.

336. A method as claimed in claim 335 wherein said data encoding is in the form of printing and said

data input means includes an optical scanner for scanning a surface of said card.

337. A method as claimed in claim 334 wherein said modification of operation comprises applying each image modification of a series of image modification modules in turn to the same image in a repetitive manner.

338. In a digital camera system comprising:

an image sensor for sensing an image;

storage means for storing said sensed image and associated system structures;

data input means for the insertion of an image modification data module for modification of said sensed image;

processor means interconnected to said image sensor, said storage means and said data input means for the control of said camera system in addition to the manipulation of said sensed image;

printer means for printing out said sensed image on demand on print media supplied to said printer means;

the improvement comprising providing an image modification data module adapted to cause said processor means to perform a series of diagnostic tests on said digital camera system and to print out the results via said printer means.

339. A digital camera system as claimed in claim 338 wherein said image modification module comprises a card having instruction data encoded on one surface thereof and said processor means includes means for interpreting said instruction data encoded on said card.

340. A digital camera system as claimed in claim 338 wherein said diagnostic tests include a cleaning cycle for said printer means so as to improve the operation of said printer means.

341. A digital camera system as claimed in claim 338 wherein said diagnostic tests include printing a continuous all black strip by said printer means.

342. A digital camera system as claimed in claim 338 wherein said printer means is an ink jet printer having a large array of nozzles and said diagnostic tests include modulating the operation of said nozzles so as to improve the operation of said ink jet printer.

343. A digital camera system as claimed in claim 338 wherein said diagnostic tests include printing out various internal operational parameters of said camera system.

344. A digital camera system as claimed in claim 338 wherein said camera system further includes a gravitational shock sensor and said diagnostic tests include printing out an extreme value of said sensor.

345. A camera system for the creation of images, said camera system comprising:

a sensor for sensing an image;

a processing means for processing said sensed image in accordance with any predetermined processing requirements;

a printer means for printing said sensed image on the surface of print media, said print media including a magnetically sensitive surface;

a magnetic recording means for recording associated information on said magnetically sensitive surface.

346. A camera system as claimed in claim 345 wherein said associated information comprises audio

information associated with said sensed image.

347. A camera system as claimed in claim 345 wherein the printer means prints said sensed image on a first surface of said print media and the magnetic recording means records said associated information on a second surface of said print media.

348. A camera system as claimed in claim 345 wherein said print media is stored on an internal detachable roll in said camera system.

349. A camera system as claimed in claim 345 wherein said magnetic sensitive surface comprises a strip affixed to the back surface of said print media.

350. A method of creating a permanent copy of an image captured on an image sensor of a handheld camera device having an interconnected integral computer device and an integral printer means for printing out on print media stored with said camera device, said method comprising the steps of:

(a) sensing an image on said image sensor;

(b) converting said image to an encoded form of said image, said encoded form having fault tolerant encoding properties;

(c) printing out said encoded form of said image as a permanent record of said image utilizing said integral printer means.

351. A method as claimed in claim 350 wherein said integral printer means includes means for printing on a first and second surface of said print media and said sensed image or a visual manipulation thereof is printed on said first surface thereof and said encoded form is printed on said second surface thereof.

352. A method as claimed in claim 350 wherein a thumbnail of said sensed image is printed alongside said encoded form of said image.

353. A method as claimed in claim 350 wherein said fault tolerant encoding comprises forming a Reed-Solomon encoded version of said image.

354. A method as claimed in claim 350 wherein said encoded form of said image includes applying a high frequency modulation signal to said encoded form such that said permanent record includes repeatable high frequency spectral components.

355. A method as claimed in claim 354 wherein said high frequency modulation signal comprises a checkerboard two dimensional signal.

356. A method as claimed in claim 350 wherein said print media and the ink supply for said printer means is stored in a print roll means which is detachable from said camera device.

357. A distribution system for the distribution of image manipulation cards for utilization in camera devices having a card manipulation interface for the insertion of said image manipulation cards for the manipulation of images within said camera devices, said distribution system comprising:

a plurality of printer devices for outputting said image manipulation cards;

each of said printer devices being interconnected to a corresponding computer system for the storage of a series of image manipulation card data necessary for the construction of said image manipulation cards;

said computer systems being interconnected via a computer network to a card distribution computer responsible for the distribution of card lists to said computer systems for printing out corresponding cards by said printer systems.

358. A distribution as claimed in claim 357 wherein said computer systems store said series of image manipulation card data in a cached manner over said computer network.

359. A distribution system as claimed in claim 357 wherein said card distribution computer is also responsible for the distribution of new image manipulation cards to said computer systems.

360. A distribution system as claimed in claim 357 wherein said image manipulation cards include seasonal event cards which are distributed to said computer systems for the printing out of cards for utilization in respect of seasonal events.

361. A data structure encoded on the surface of an object comprising:

a series of block data regions with each of said block data regions including:

an encoded data region containing data to be decoded in an encoded form;

a series of clock marks structures located around a first peripheral portion of said encoded data region; and

a series of easily identifiable target structures located around a second peripheral portion of said encoded data region.

362. A data structure as claimed in claim 361 wherein said block data regions further include an orientation data structure located round a third peripheral portion of said encoded data region.

363. A data structure as claimed in claim 362 wherein said orientation data structure comprises a line of equal data points along an edge of said peripheral portion.

364. A data structure as claimed in claim 363 wherein said clock marks structures include a first line of equal data points in addition to a substantially adjacent second line of alternating data points located along an edge of said encoded data region.

365. A data structure as claimed in claim 364 wherein said clock mark structures are located on mutually opposite sides of said encoded data region.

366. A data structure as claimed in claim 361 wherein said target structures comprise a series of spaced apart block sets of data points having a substantially constant value of a first magnitude except for a core portion of a substantially opposite magnitude to said first magnitude.

367. A data structure as claimed in claim 366 wherein said block sets further includes a target number indicator structure comprising a contiguous group of said values of said substantially opposite magnitude.

368. A data structure as claimed in any of claims 361 to 367 wherein said data structure comprises a series of printed dots on a substrate surface.

369. A method of decoding a data structure encoded on the surface of an object, said data structure comprising:

a series of block data regions with each of said block data regions including:

an encoded data region containing data to be decoded in an encoded form;

a series of clock marks structures located around a first peripheral portion of said encoded data region;

a series of easily identifiable target structures located around a second peripheral portion of said encoded data region;

the method comprising the steps of:

(a) scanning said data structure;

(b) locating the start of said data structure;

(c) locating said target structures including determining a current orientation of said target structures;

(d) locating said clock mark structures from the position of said target structures;

(e) utilizing said clock mark structures to determine an expected location of bit data of said encoded data region; and

(f) determining an expected data value for each of said bit data.

370. A method as claimed in claim 369 wherein said clock marks structures include a first line of equal data points in addition to a substantially adjacent second line of alternating data points located along an edge of said encoded data region and said utilising step (e) comprises running along said second line of alternating data points utilizing a pseudo phase locked loop type algorithm so as to maintain a current location within said clock mark structures.

371. A method as claimed in claim 370 wherein said determining step (f) comprises dividing a sensed bit value into three contiguous regions comprising a middle region and a first lower and a second upper extreme regions, and:

with those values within a first lower region, determining the corresponding bit value to be a first lower value;

with those values within a second upper region, determining the corresponding bit value to be a second upper value;

with those values in said middle regions, utilising the spatially surrounding values to determine whether said value is of a first lower value or a second upper value.

372. A method of determining an output data value of sensed data comprising:

(a) dividing a sensed data value into three contiguous regions comprising a middle region and a first lower and a second upper extreme regions, and:

with those values within a first lower region, determining the corresponding bit value to be a first lower value;

with those values within a second upper region, determining the corresponding bit value to be a second upper value; and

with those values in said middle regions, utilising the spatially surrounding values to determine whether said value is of a first lower value or a second upper value.

373. A fluid supply to fluid chambers fabricated on a planar wafer, said supply being by means of through wafer channels, wherein said through wafer channels each supply a plurality of fluid chambers.

374. A fluid supply as claimed in claim 373 wherein said through wafer channels comprise etchant holes in one wall exposed to atmospheric conditions.

375. A fluid supply as claimed in claim 373 and 2 wherein said fluid chambers each include a fluid filter in one wall.

376. A fluid supply as claimed in claim 373 wherein said through-channels are constructed by means of an anisotropic etch of the wafer material.

377. A fluid supply as claimed in claim 373 wherein said wafer material is substantially silicon.

378. A fluid supply as claimed in claim 373 wherein said anisotropic etch utilises of a high density low

pressure etch.

379. A fluid supply means for supplying a plurality of different fluids to a plurality of different supply slots said supply slots are being spaced apart at periodic intervals in an interleaved manner said apparatus comprising;

a. fluid inlet means for each of said plurality of different fluids.

b. a main channel flow means for each of said different fluids, connected to said fluid inlet means and running past each of said supply slots; and

c. sub-channel flow means connecting each of said supply slots to a corresponding main channel flow means;

wherein the number of fluids is greater than 2 and at least two of said main channel flow means run along the first surface of a moulded flow supply unit and another of said main channel flow means runs along the top surface of said moulded piece with the subchannel flow means being interconnected with said slots by means of through-holes through the surface of the said moulded piece.

380. A fluid supply means is claimed in claim 379 wherein said supply means is plastic injection moulded.

381. A fluid supply means that as claimed in claim 379 wherein the pitch rate of said slots is substantially less than or equal to 1,000 slots per inch.

382. A fluid supply means as claimed in claimed 1 wherein the collection of slots runs substantially the width of a photograph.

383. A fluid supply means as claimed in claim 379 further comprising:

a plurality of roller slot means for the reception of one or more pinch rollers and wherein said fluid comprises ink and said rollers are utilised to control the passage of a print media across a print-head interconnected to said slots.

384. A fluid supply means as claimed in claim 383 wherein said slots are divided into corresponding colour slots with each series of colour slots being arranged in columns.

385. A fluid supply means as claimed in claim 379 wherein at least one of said channels is exposed when fabricated and is sealed by means of utilising sealing tape to seal the exposed surface of said channel.

386. A fluid supply means as claimed in claim 379 wherein said fluid supply means is further provided with a TAB slot for the reception of Tape Automated Bonded (TAB) wires.

387. A printer mechanism for printing images utilizing at least one ink ejection mechanism supplied through an ink supply channel, said mechanism comprising:

a series of ink supply portals at least one per output color, adapted to engage a corresponding ink supply mechanism for the supply of ink to said printer;

a series of conductive connector pads along an external surface of said printer mechanism;

a page width print head having a series of ink ejection mechanisms for the ejection of ink;

an ink distribution system for distribution of ink from said ink supply portals to the ink ejection mechanisms of said page width print head;

a plurality of interconnect control wires interconnecting said page width print head to said conductive connector pads;

wherein said printer mechanism is adapted to be detachably inserted in a housing

mechanism containing interconnection portions for interconnecting to said conductive connector pads and said ink supply connector of interconnection to said ink supply portals for the supply of ink by said ink supply mechanism.

388. A printer mechanism as claimed in claim 387 wherein said plurality of interconnect control wires form a tape automated bonded sheet which wraps around an external surface of said printer mechanism and which is interconnected to said conductive connector pads.

389. A printer mechanism as claimed in claim 387 wherein said interconnect control wires comprise a first set of wires interconnecting said conductive connector pads and running along the length of said print head, substantially parallel to one another and a second set of wires running substantially parallel to one another from the surface of said print head, each of said first set of wires being interconnected to a number of said second set of wires.

390. A printer mechanism as claimed in claim 387 wherein said ink supply portals include a thin diaphragm portion which is pierced by said ink supply connector upon insertion into said housing mechanism.

391. A printer mechanism as claimed in claim 387 wherein said page width print head includes a number of substantially identical repeatable units each containing a predetermined number of ink ejection mechanisms, each of said repeatable units including a standard interface mechanism containing a predetermined number of interconnect wires, each of said standard interface mechanism interconnecting as a group with said conductive connector pads.

392. A printer mechanism as claimed in claim 387 wherein said print head is constructed from a silicon wafer, separated into page width wide strips.

393. A method of providing for resistance to monitoring of an integrated circuit by means of monitoring current changes, said method comprising the step of including a spurious noise generation circuit as part of said integrated circuit.

394. A method as claimed in claim 393 wherein said noise generation circuit comprises a random number generator.

395. A method as claimed in claim 394 wherein said random number generator comprises a LFSR (Linear Feedback Shift Register).

396. A CMOS circuit having a low power consumption, said circuit including a p-type transistor having a gate connected to a first clock and to an input and an n-type transistor connected to a second clock and said input and wherein said CMOS circuit is operated by transitioning said first and second clocks wherein said transitions occur in a non-overlapping manner.

397. A CMOS circuit as claimed in claim 396 wherein said circuit is positioned substantially adjacent a second circuit having high power switching characteristics.

398. A CMOS circuit as claimed in claim 397 wherein said second circuit comprises a noise generation circuit.

399. A method of providing for resistance to monitoring of an memory circuit having multiple level states corresponding to different output states, said method comprising utilizing the intermediate states only for valid output states.

400. A method as claimed in claim 399 wherein said memory comprises flash memory.

401. A method as claimed in claim 399 wherein said memory includes a parity bit.

402. A method of providing for resistance to tampering of an integrated circuit comprising utilizing a circuit path attached to a random noise generator to monitor attempts at tampering with said integrated circuit.

403. A method as claimed in claim 402 wherein said circuit path includes a first path and a second path which are substantially inverses of one another and which are further connected to various test circuitry and which are exclusive ORed together to produce a reset output signal.

404. A method as claimed in claim 402 wherein said circuit paths substantially cover said random noise generator.

405. A Tamper Detection Line connected at one end to a large resistance attached to ground and at a second end to a second large resistor attached to a power supply, said tamper detection line further being interconnected to a comparator that compares against the expected voltage to within a predetermined tolerance, further in between said resistance are interconnected a series of test, each outputting a large resistance such that if tampering is detected by one of said tests said comparator is caused to output a reset signal.

406. An authentication system for determining the validity of an attached unit to be authenticated comprising:

a central system unit for interrogation of first and second secure key holding units;

first and second secure key holding objects attached to said central system unit, wherein said second key holding object is further permanently attached to said attached unit;

wherein said central system unit is adapted to interrogate said first secure key holding object so as to determine a first response and to utilize said first response to interrogate said second secure key holding object to determine a second response, and to further compare said first and second response to determine whether said second secure key holding object is attached to a valid attached unit.

407. A system as claimed in claim 406 wherein said second secure key holding object further includes a response having an effectively monotonically decreasing magnitude factor such that, after a predetermined utilization of said attached unit and or said , said attached unit ceases to function.

408. A system as claimed in claim 406 wherein said attached unit comprises a consumable product.

409. A system as claimed in claim 406 wherein said central system unit interrogates said first secure key holding object with a substantially random number and receives said first response, said central system then utilizes said first response in the interrogation of said second secure key holding object to determine said second response, said central system unit then utilizes said second response to interrogate said first secure key holding unit to determine a validity measure of said second response.

410. A system as claimed in claim 406 wherein said system is utilized to authenticate a consumable for a printer.

411. A system as claimed in claim 410 wherein said printer comprises and ink jet printer and said consumable includes ink.

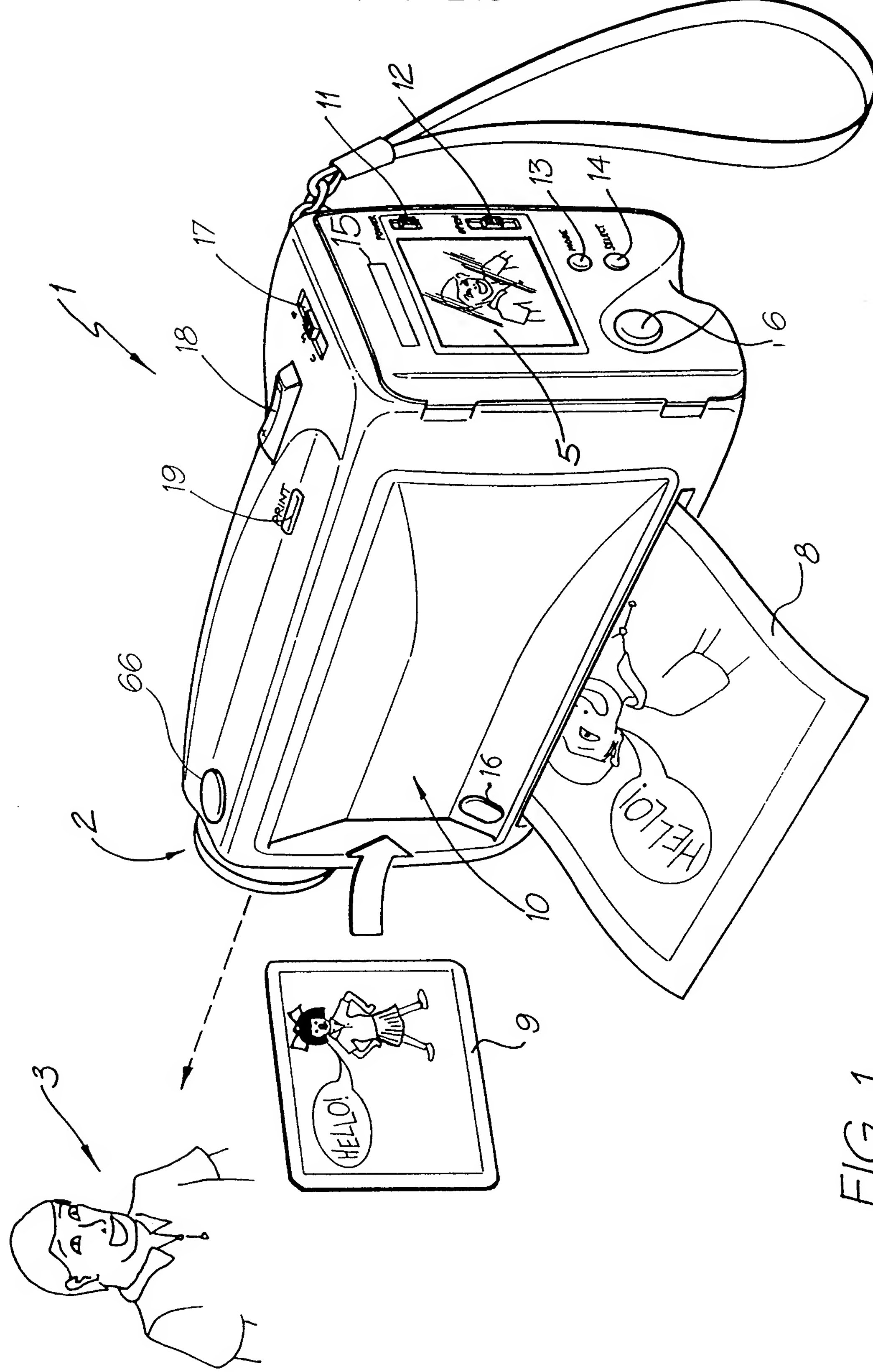


FIG. 1

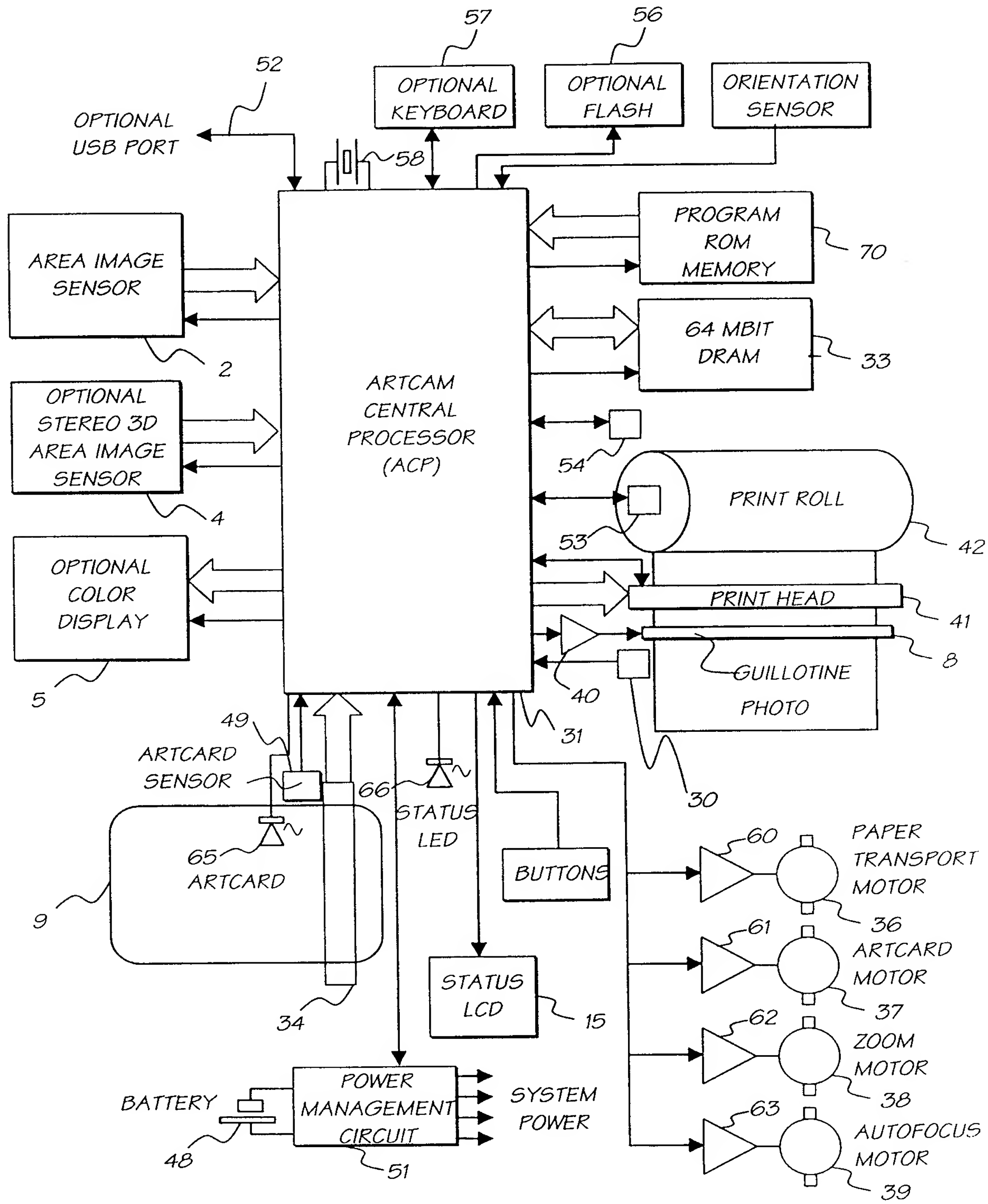
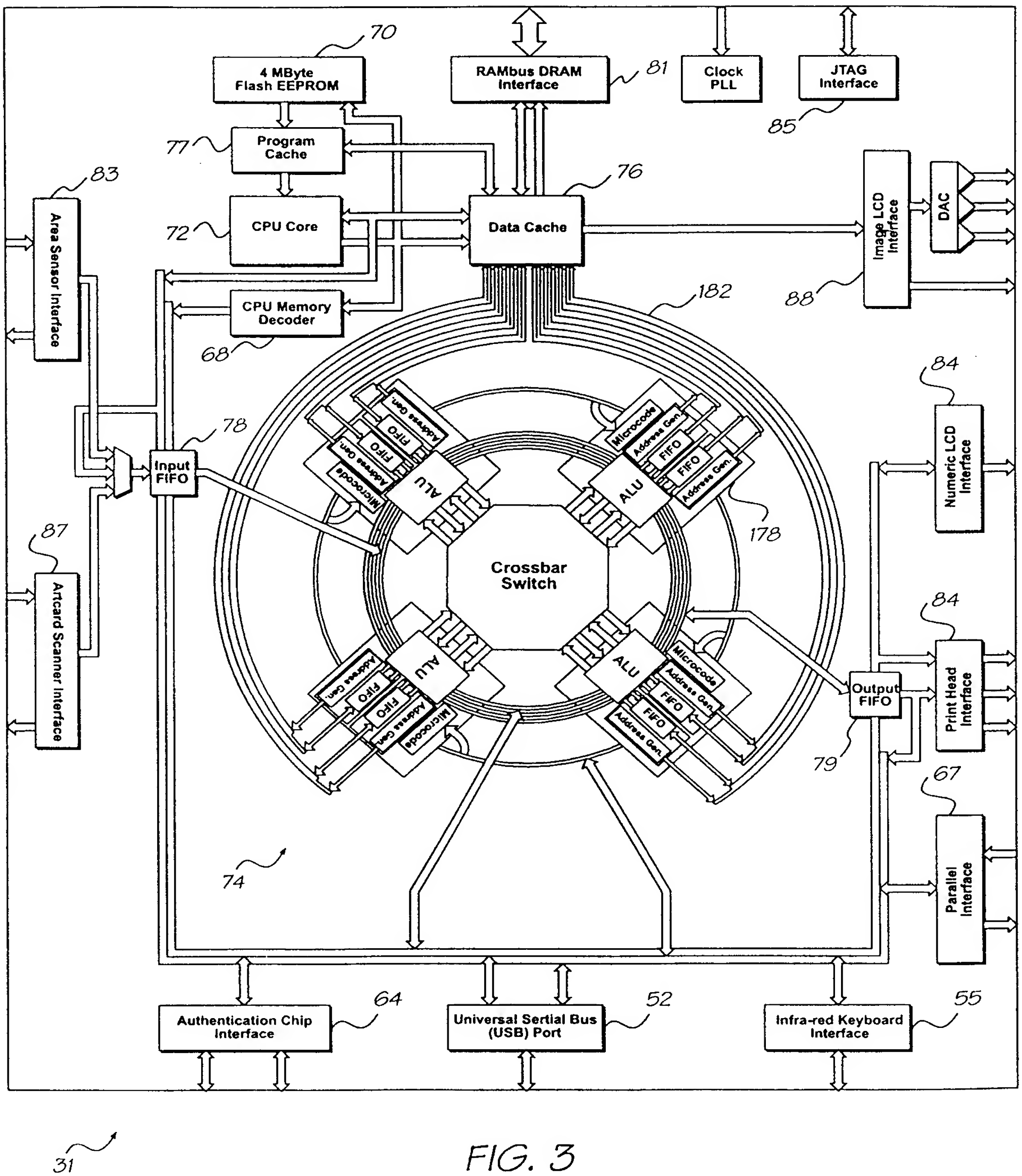

57
56
52
OPTIONAL KEYBOARD
OPTIONAL FLASH
ORIENTATION SENSOR
OPTIONAL USB PORT
58
AREA IMAGE SENSOR
PROGRAM ROM MEMORY
70
64 MBIT DRAM
33
2
OPTIONAL STEREO 3D AREA IMAGE SENSOR
ARTCAM CENTRAL PROCESSOR (ACP)
54
PRINT ROLL
4
53
42
OPTIONAL COLOR DISPLAY
PRINT HEAD
41
8
GUILLOTINE
40
PHOTO
5
49
31
ARTCARD SENSOR
66
STATUS LED
30
65
ARTCARD
BUTTONS
60
PAPER TRANSPORT MOTOR
9
36
61
ARTCARD MOTOR
STATUS LCD
34
15
37
62
ZOOM MOTOR
38
POWER MANAGEMENT CIRCUIT
SYSTEM POWER
BATTERY
63
AUTOFOCUS MOTOR
48
51
39

FIG. 2



70
4 MByte Flash EEPROM
RAMbus DRAM Interface
81
Clock PLL
JTAG Interface
85
77
Program Cache
83
76
72
CPU Core
Data Cache
Image LCD Interface
DAC
Area Sensor Interface
CPU Memory Decoder
182
88
68
84
78
Input FIFO
Address Gen.
FIFO
Microcode
ALU
178
Numeric LCD Interface
87
Crossbar Switch
Artcard Scanner Interface
84
Output FIFO
Print Head Interface
79
67
74
Parallel Interface
Authentication Chip Interface
64
Universal Serial Bus (USB) Port
52
Infra-red Keyboard Interface
55
31

FIG. 3

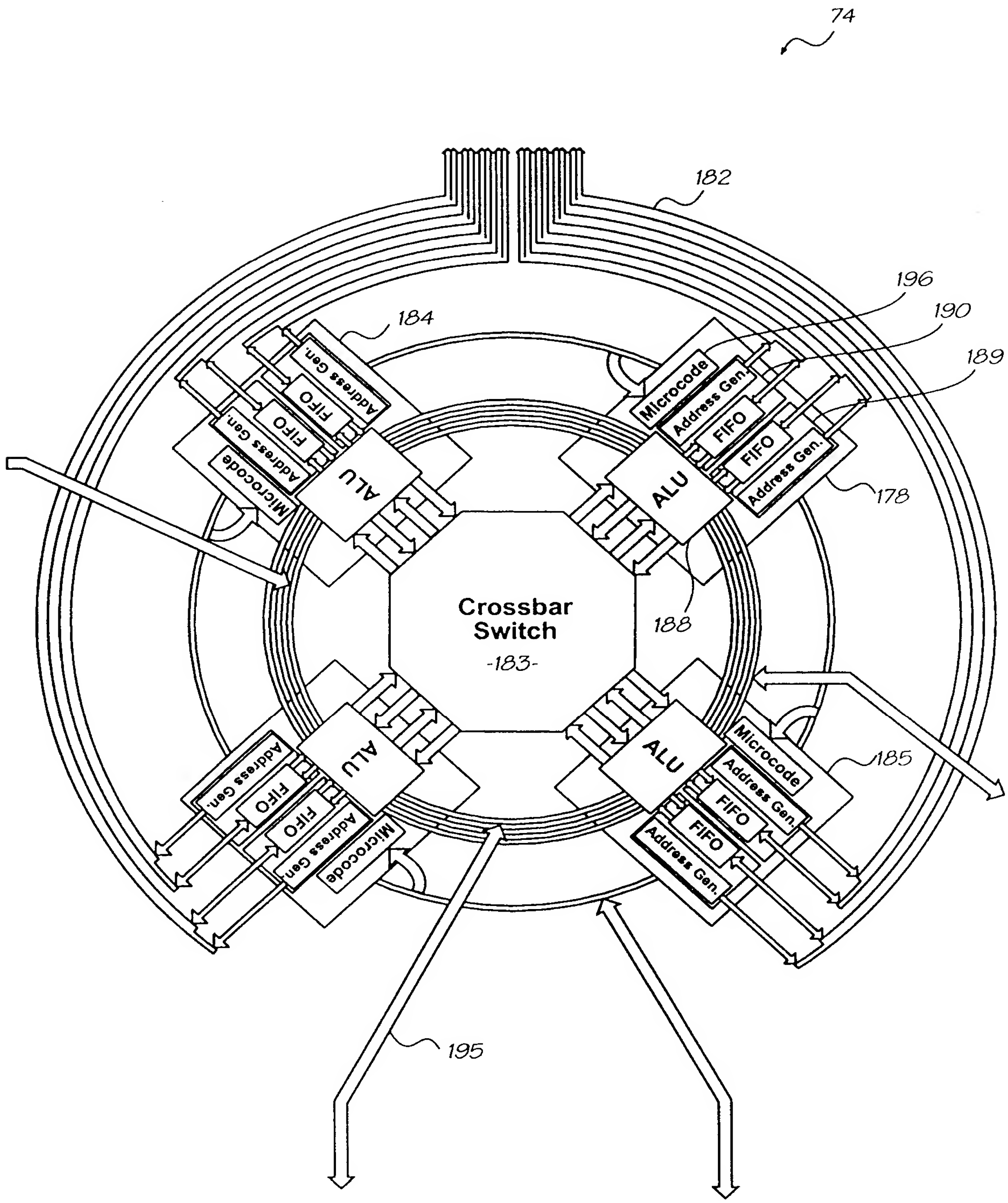

74
182
184
196
190
189
178
Microcode
Address Gen.
FIFO
FIFO
Address Gen.
ALU
Address Gen.
FIFO
FIFO
Address Gen.
Microcode
ALU
Crossbar
Switch
-183-
188
ALU
Microcode
Address Gen.
FIFO
FIFO
Address Gen.
185
ALU
Address Gen.
FIFO
FIFO
Address Gen.
Microcode
195

FIG. 3(a)

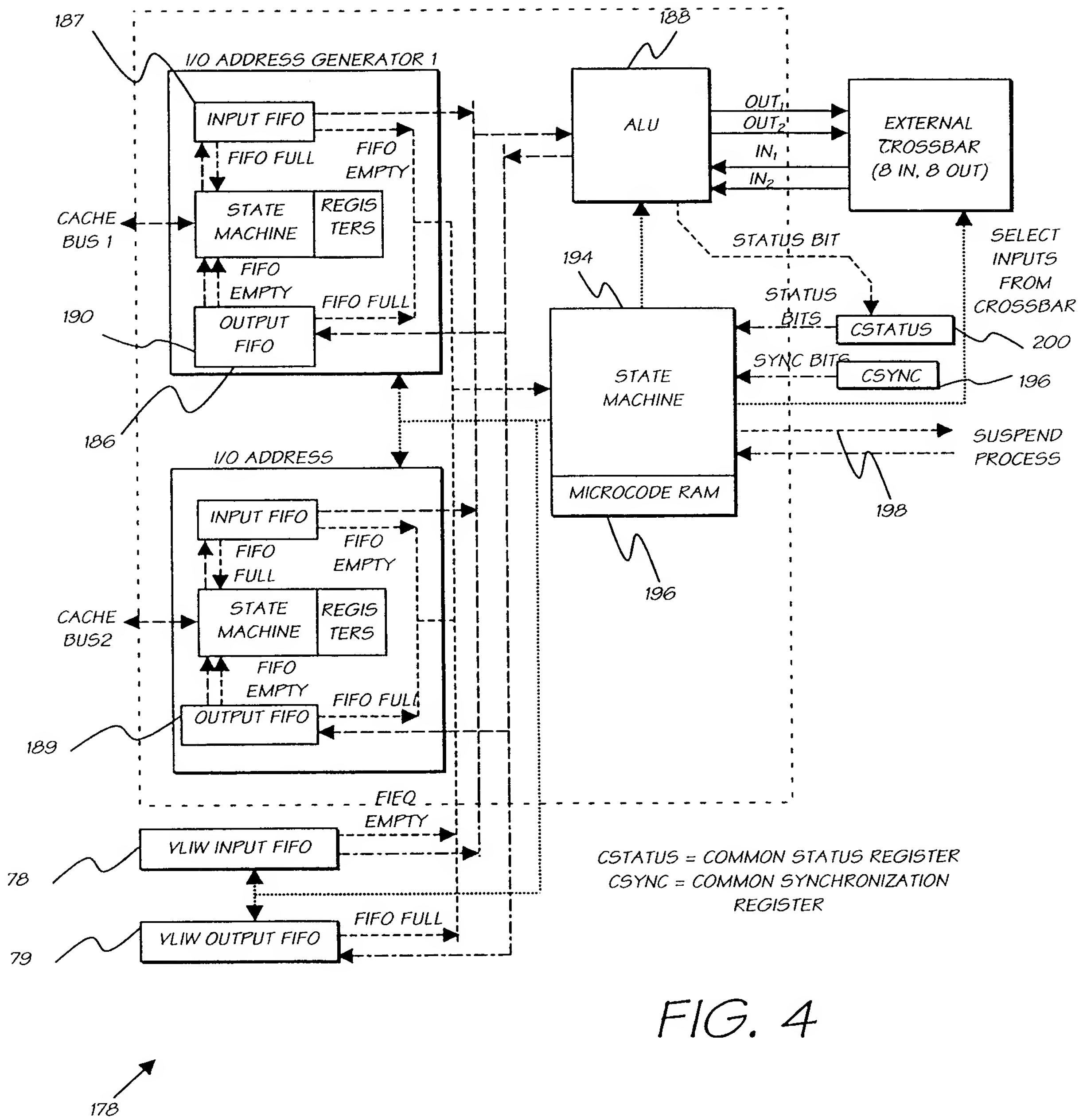

187
188
I/O ADDRESS GENERATOR 1
INPUT FIFO
FIFO FULL
FIFO EMPTY
CACHE BUS 1
STATE MACHINE
REGIS TERS
FIFO EMPTY
FIFO FULL
190
OUTPUT FIFO
186
ALU
OUT1
OUT2
IN1
IN2
EXTERNAL CROSSBAR (8 IN, 8 OUT)
STATUS BIT
SELECT INPUTS FROM CROSSBAR
194
STATUS BITS
CSTATUS
200
SYNC BITS
CSYNC
196
STATE MACHINE
SUSPEND PROCESS
MICROCODE RAM
198
196
I/O ADDRESS
INPUT FIFO
FIFO FULL
FIFO EMPTY
CACHE BUS2
STATE MACHINE
REGIS TERS
FIFO EMPTY
FIFO FULL
OUTPUT FIFO
189
FIFO EMPTY
VLIW INPUT FIFO
78
FIFO FULL
VLIW OUTPUT FIFO
79
CSTATUS = COMMON STATUS REGISTER
CSYNC = COMMON SYNCHRONIZATION REGISTER
178

FIG. 4

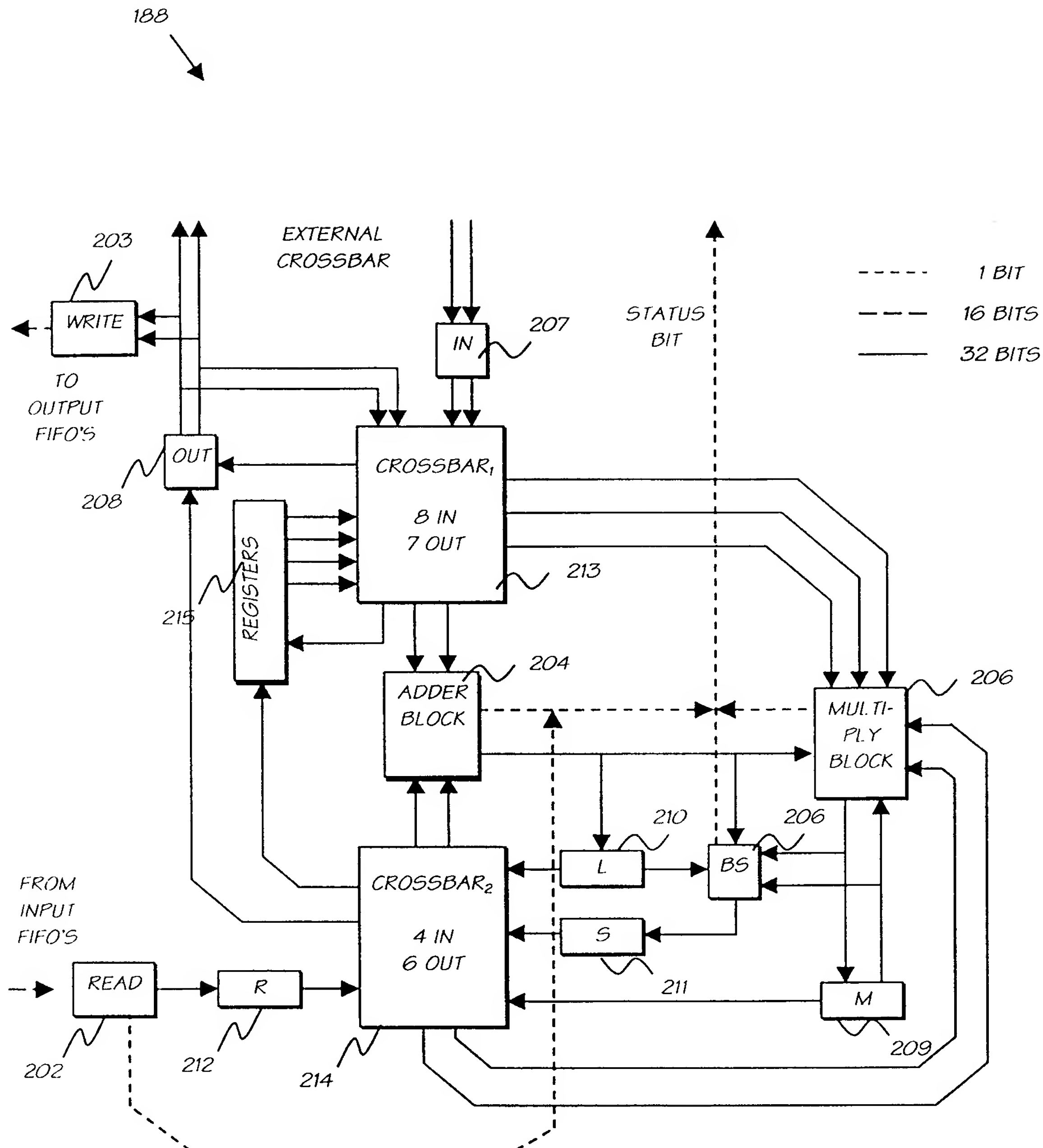

188
203
WRITE
TO OUTPUT FIFO'S
EXTERNAL CROSSBAR
IN
207
STATUS BIT
1 BIT
16 BITS
32 BITS
OUT
208
CROSSBAR₁
8 IN
7 OUT
213
REGISTERS
215
ADDER BLOCK
204
MULTI-PLY BLOCK
206
210
206
L
BS
S
211
M
209
FROM INPUT FIFO'S
READ
R
CROSSBAR₂
4 IN
6 OUT
202
212
214

FIG. 5

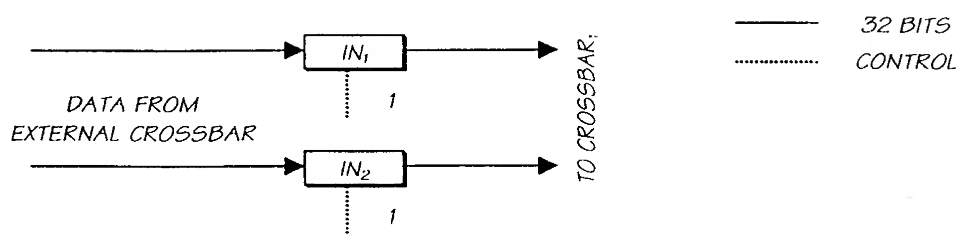

32 BITS
CONTROL
IN_1
DATA FROM
EXTERNAL CROSSBAR
1
IN_2
1
TO CROSSBAR;

FIG. 6

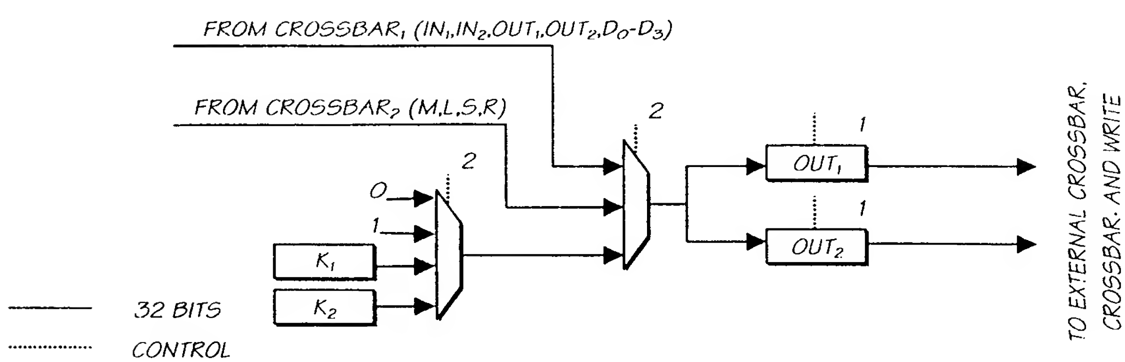

FROM $CROSSBAR_1$ (IN_1,IN_2,OUT_1,OUT_2,D_0-D_3)
FROM $CROSSBAR_2$ (M,L,S,R)
2
2
0
1
K_1
K_2
1
OUT_1
1
OUT_2
32 BITS
CONTROL
TO EXTERNAL CROSSBAR,
CROSSBAR, AND WRITE

FIG. 7

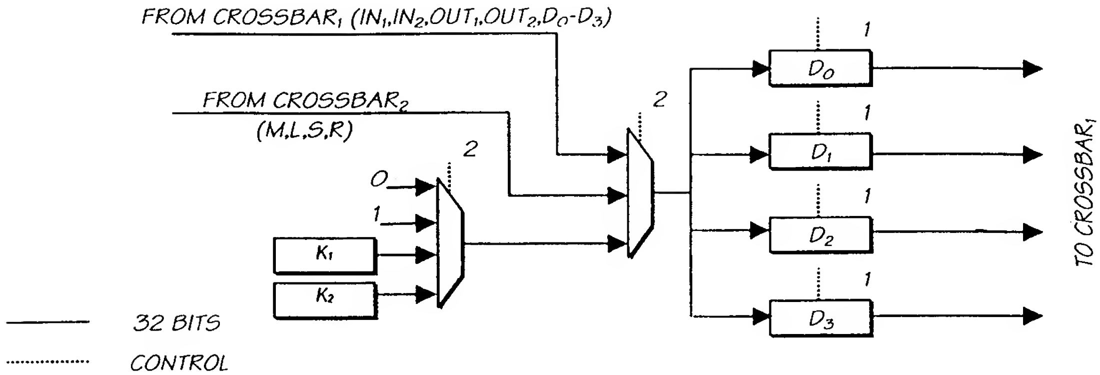

FROM CROSSBAR1 (IN1,IN2,OUT1,OUT2,D0-D3)
FROM CROSSBAR2
(M,L,S,R)
2
0
1
K1
K2
2
1
D0
1
D1
1
D2
1
D3
TO CROSSBAR1
32 BITS
CONTROL

FIG. 8

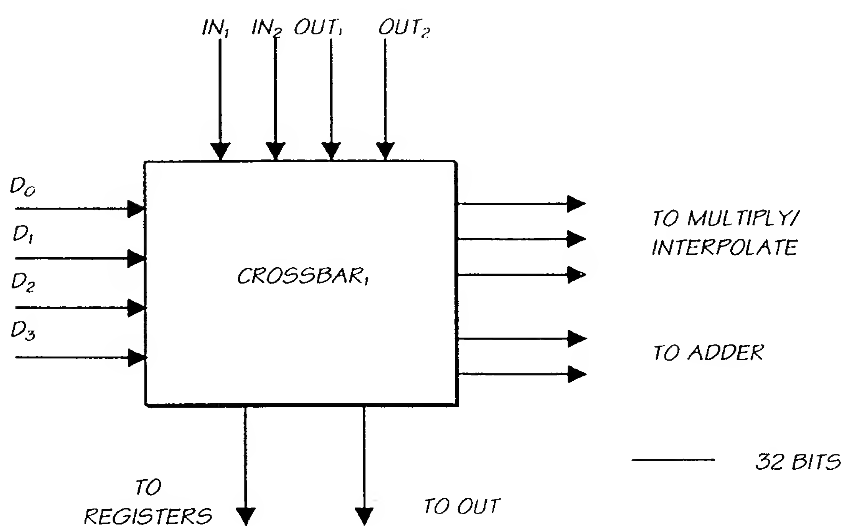

IN1
IN2
OUT1
OUT2
D0
D1
D2
D3
CROSSBAR1
TO MULTIPLY/
INTERPOLATE
TO ADDER
32 BITS
TO
REGISTERS
TO OUT

FIG. 9

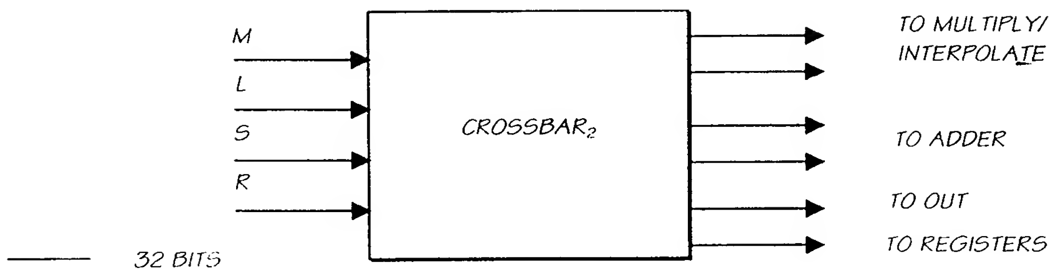

M
L
S
R
CROSSBAR$_2$
TO MULTIPLY/ INTERPOLATE
TO ADDER
TO OUT
TO REGISTERS
32 BITS

FIG. 10

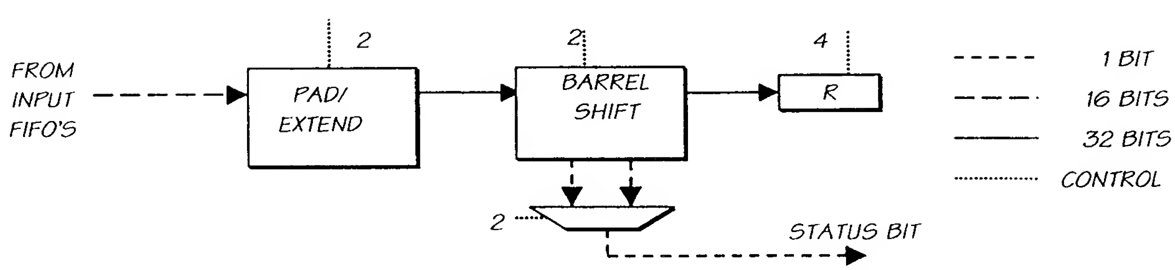

FROM INPUT FIFO'S
2
PAD/ EXTEND
2
BARREL SHIFT
4
R
2
STATUS BIT
1 BIT
16 BITS
32 BITS
CONTROL

FIG. 11

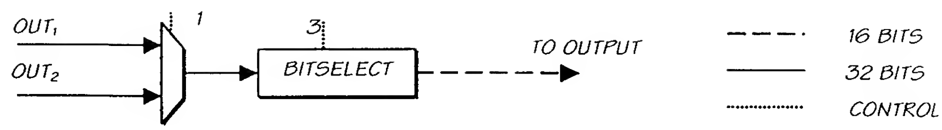


FIG. 12

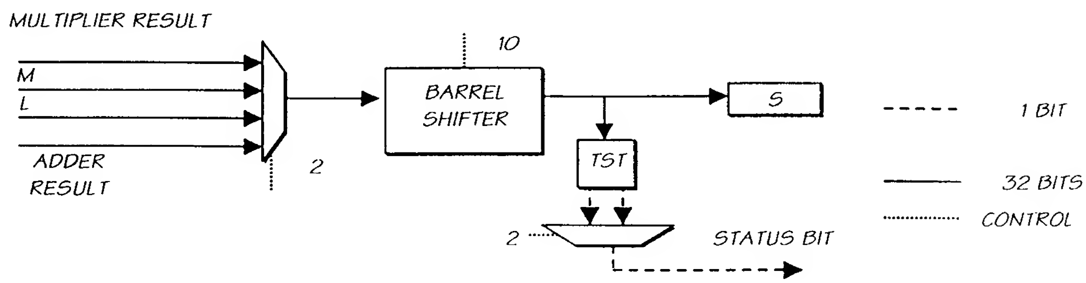


FIG. 13

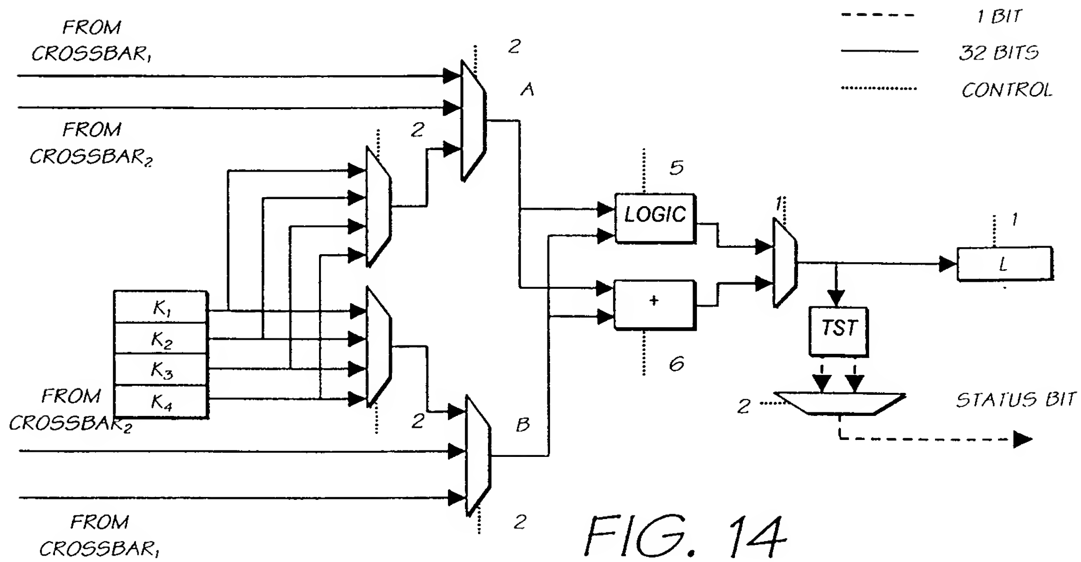


FIG. 14

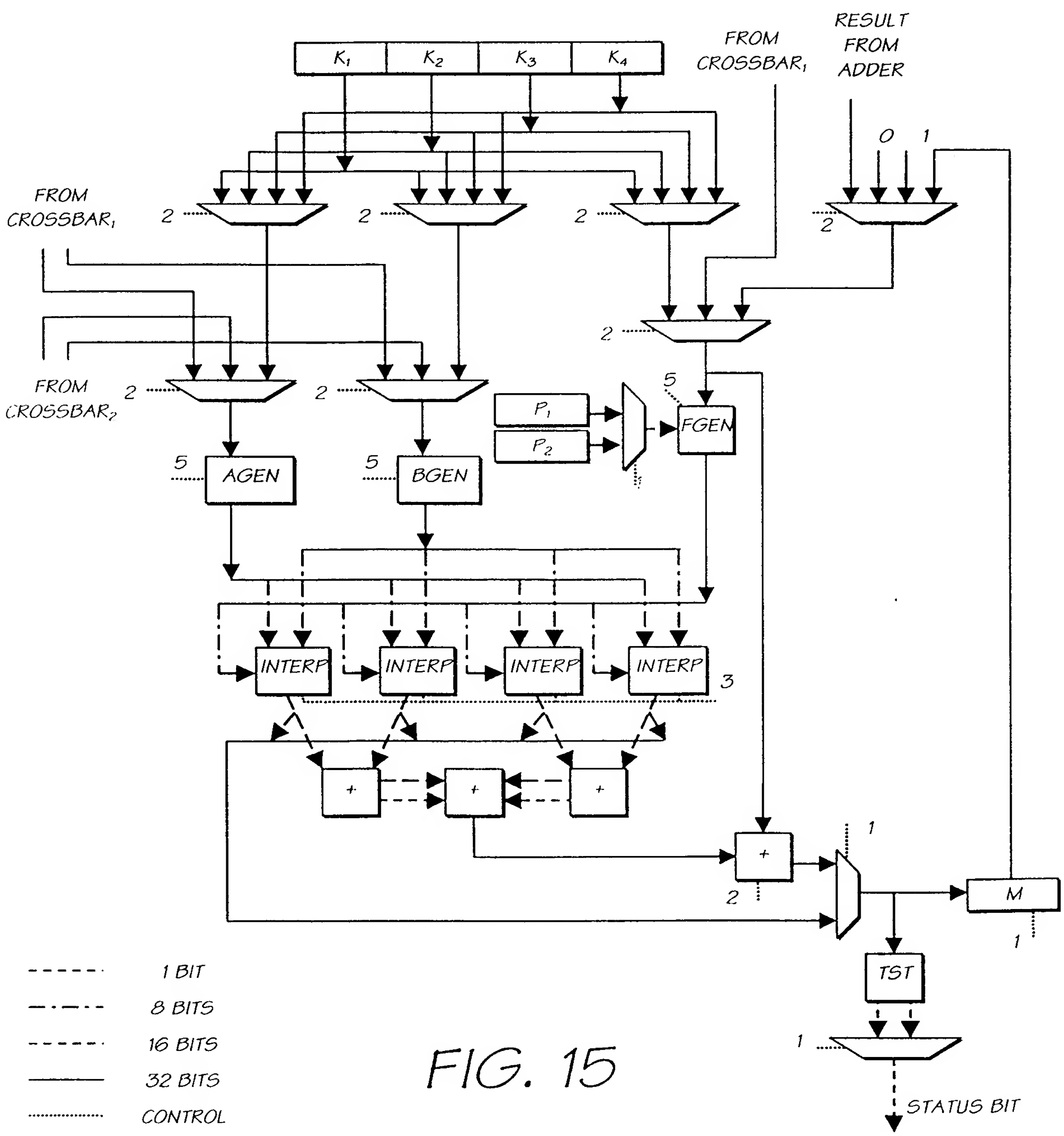

K1
K2
K3
K4
FROM CROSSBAR1
RESULT FROM ADDER
0
1
FROM CROSSBAR1
FROM CROSSBAR2
2
5
AGEN
BGEN
P1
P2
FGEN
INTERP
INTERP
INTERP
INTERP
3
+
+
+
+
M
TST
STATUS BIT
1 BIT
8 BITS
16 BITS
32 BITS
CONTROL

FIG. 15

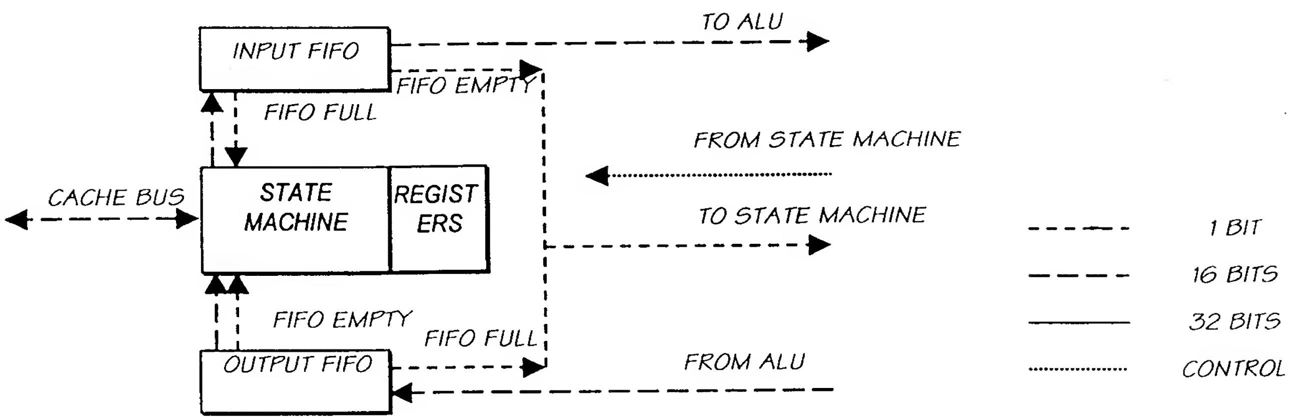


FIG. 16

ORDER OF PIXELS PRESENTED BY A SEQUENTIAL READ ITERATOR ON A 4 X 2 IMAGE WITH PADDING.

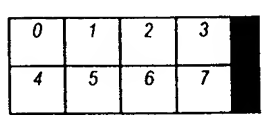


FIG. 17

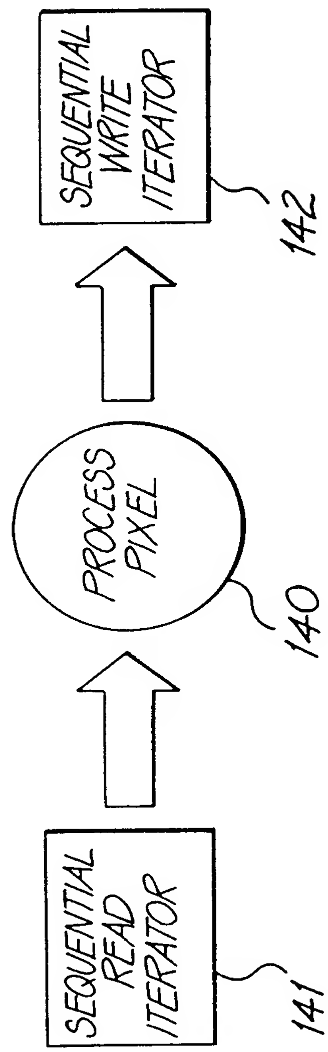

SEQUENTIAL READ ITERATOR
141
PROCESS PIXEL
140
SEQUENTIAL WRITE ITERATOR
142

FIG. 18

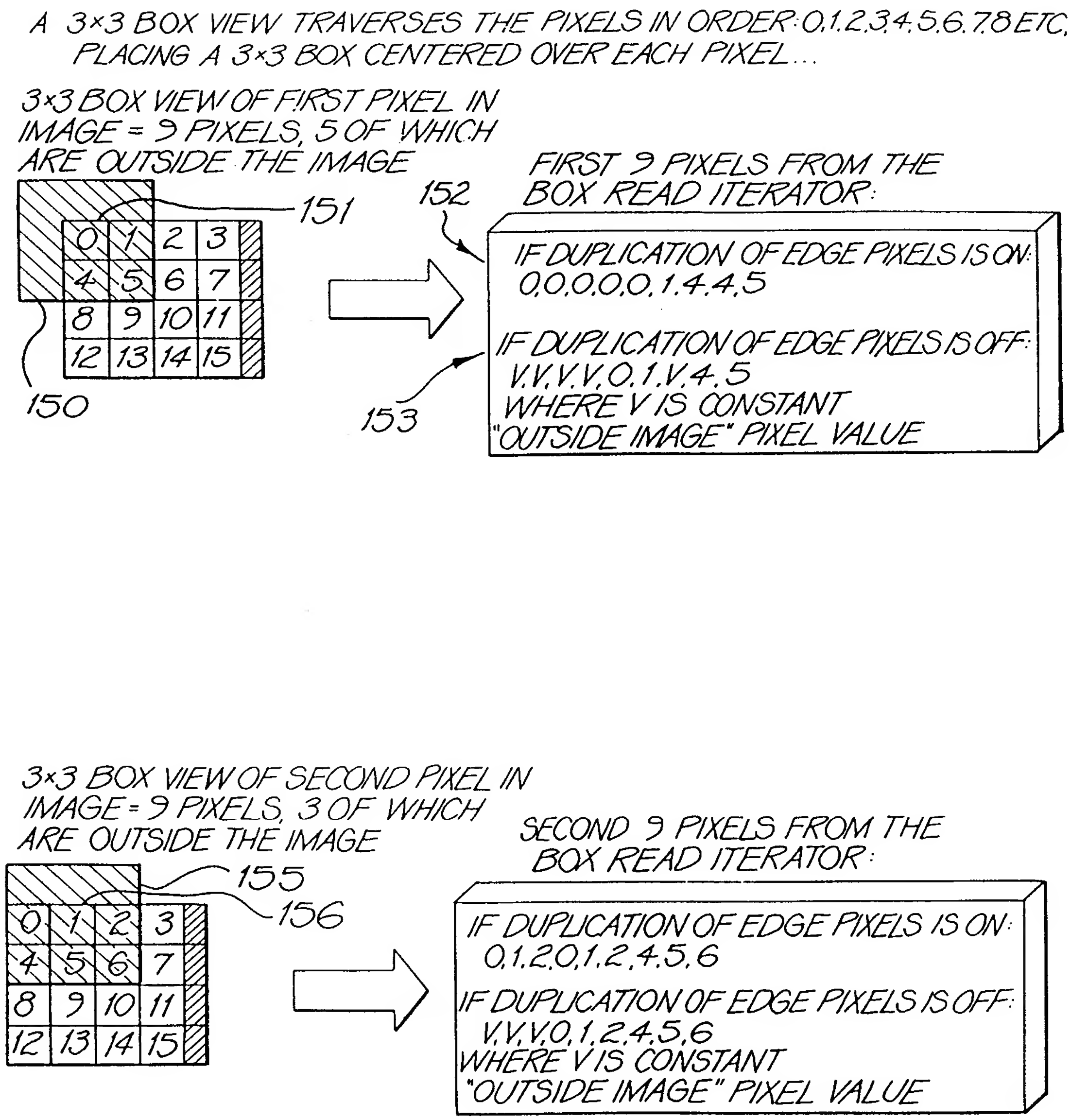

A 3×3 BOX VIEW TRAVERSES THE PIXELS IN ORDER: 0,1,2,3,4,5,6,7,8 ETC,
PLACING A 3×3 BOX CENTERED OVER EACH PIXEL...
3×3 BOX VIEW OF FIRST PIXEL IN IMAGE = 9 PIXELS, 5 OF WHICH ARE OUTSIDE THE IMAGE
FIRST 9 PIXELS FROM THE BOX READ ITERATOR:
151
152
0 1 2 3
4 5 6 7
8 9 10 11
12 13 14 15
150
153
IF DUPLICATION OF EDGE PIXELS IS ON: 0,0,0,0,0,1,4,4,5
IF DUPLICATION OF EDGE PIXELS IS OFF: V,V,V,V,0,1,V,4,5
WHERE V IS CONSTANT "OUTSIDE IMAGE" PIXEL VALUE
3×3 BOX VIEW OF SECOND PIXEL IN IMAGE = 9 PIXELS, 3 OF WHICH ARE OUTSIDE THE IMAGE
SECOND 9 PIXELS FROM THE BOX READ ITERATOR:
155
156
0 1 2 3
4 5 6 7
8 9 10 11
12 13 14 15
IF DUPLICATION OF EDGE PIXELS IS ON: 0,1,2,0,1,2,4,5,6
IF DUPLICATION OF EDGE PIXELS IS OFF: V,V,V,0,1,2,4,5,6
WHERE V IS CONSTANT "OUTSIDE IMAGE" PIXEL VALUE

FIG. 19

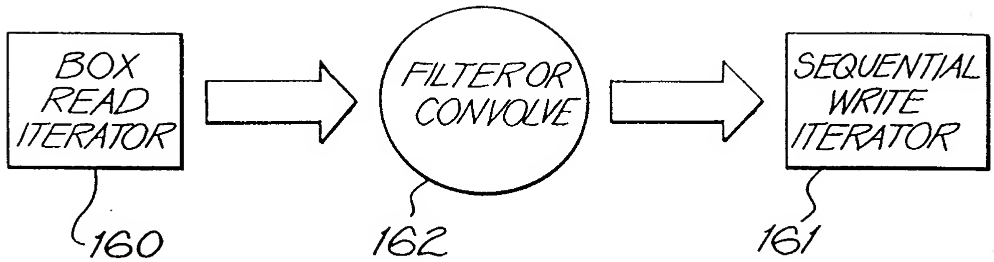

BOX
READ
ITERATOR
FILTER OR
CONVOLVE
SEQUENTIAL
WRITE
ITERATOR
160
162
161

FIG. 20

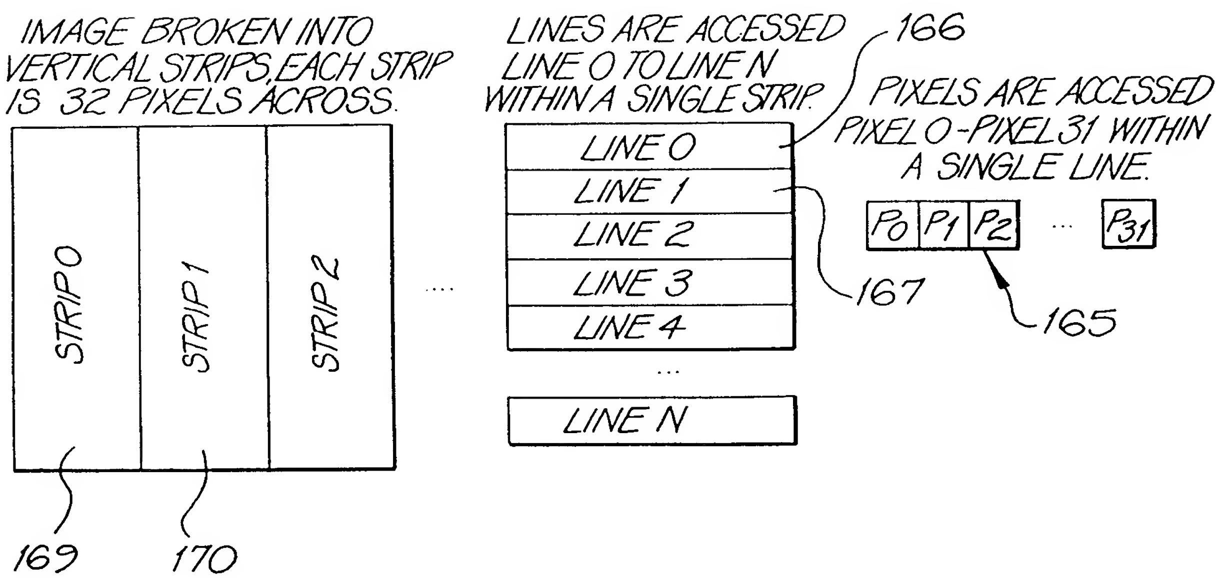


IMAGE BROKEN INTO VERTICAL STRIPS, EACH STRIP IS 32 PIXELS ACROSS.
LINES ARE ACCESSED LINE 0 TO LINE N WITHIN A SINGLE STRIP.
166
PIXELS ARE ACCESSED PIXEL 0 - PIXEL 31 WITHIN A SINGLE LINE.
STRIP 0
STRIP 1
STRIP 2
LINE 0
LINE 1
LINE 2
LINE 3
LINE 4
LINE N
P0
P1
P2
P31
167
165
169
170

FIG. 21

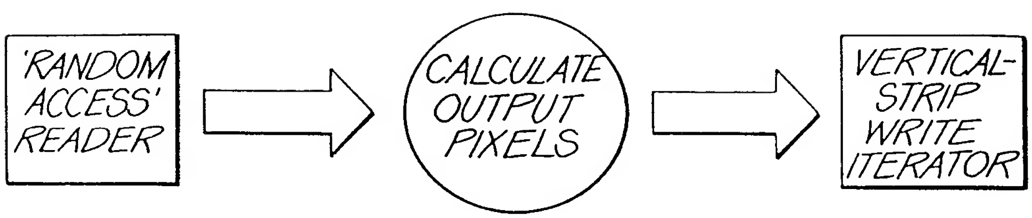

'RANDOM ACCESS' READER
CALCULATE OUTPUT PIXELS
VERTICAL-STRIP WRITE ITERATOR

FIG. 22

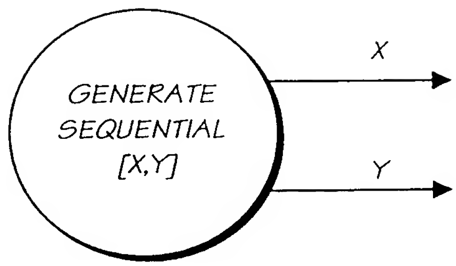


FIG. 23

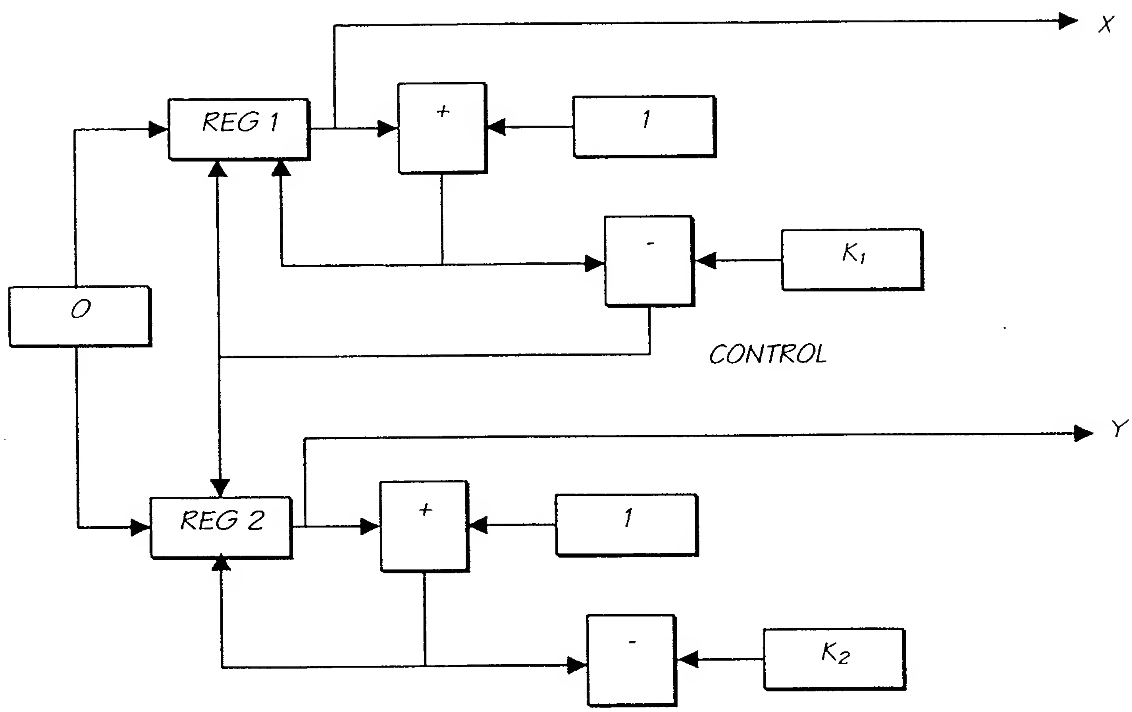


FIG. 24

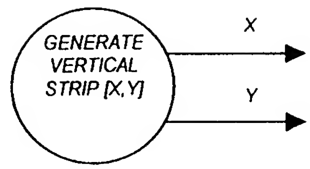

GENERATE
VERTICAL
STRIP [X,Y]
X
Y

FIG. 25

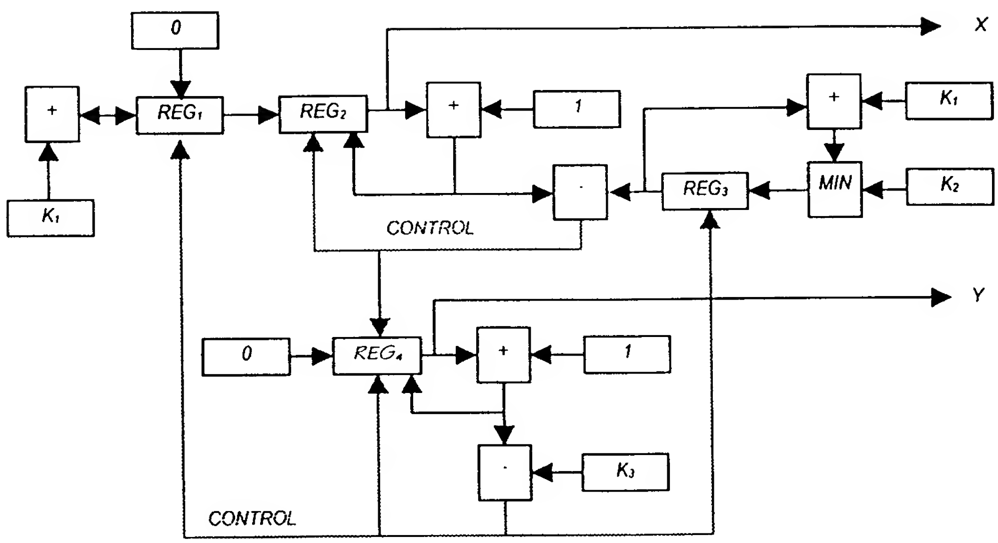
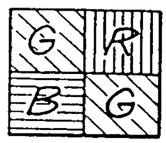

0
X
+
REG₁
REG₂
+
1
+
K₁
K₁
-
REG₃
MIN
K₂
CONTROL
Y
0
REG₄
+
1
-
K₃
CONTROL

FIG. 26



2x2 PIXEL BLOCK FROM CCD

FIG. 27

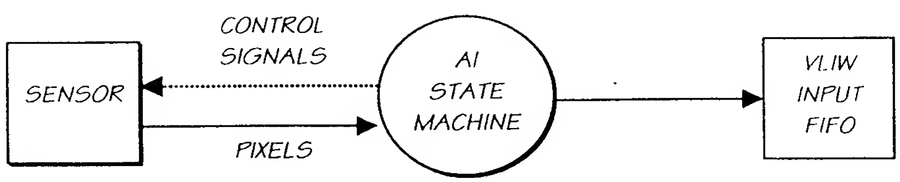


FIG. 28

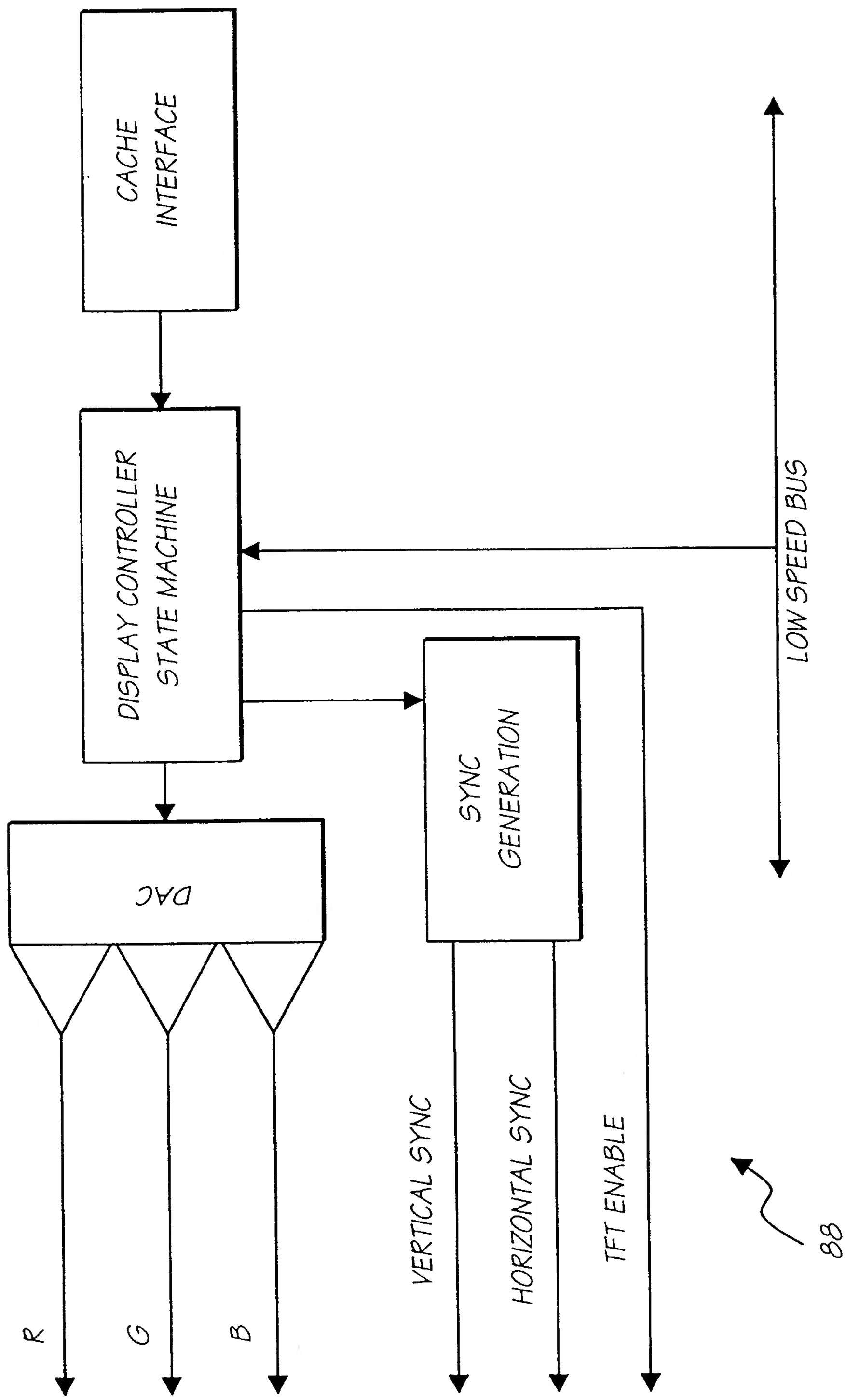

CACHE INTERFACE
DISPLAY CONTROLLER STATE MACHINE
SYNC GENERATION
DAC
LOW SPEED BUS
R
G
B
VERTICAL SYNC
HORIZONTAL SYNC
TFT ENABLE
88

FIG. 29

FIG. 30

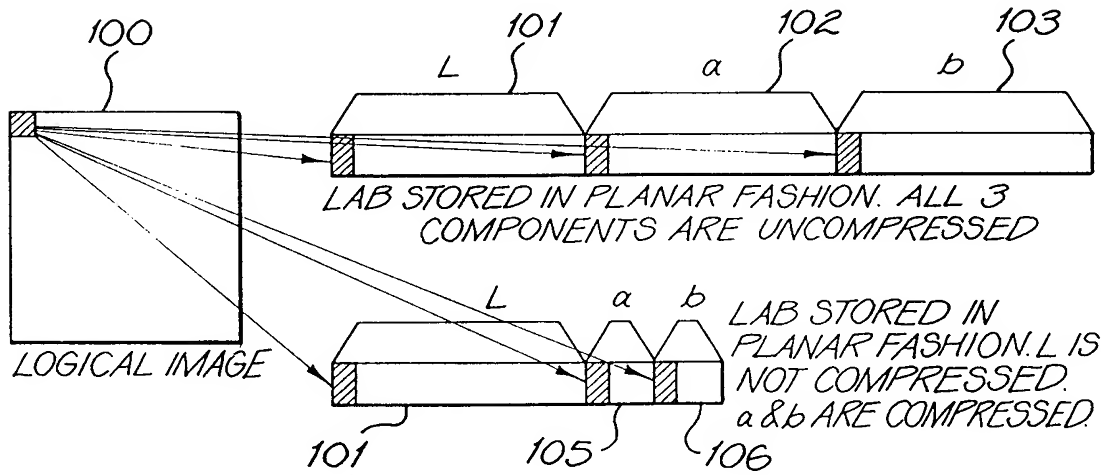


FIG. 31

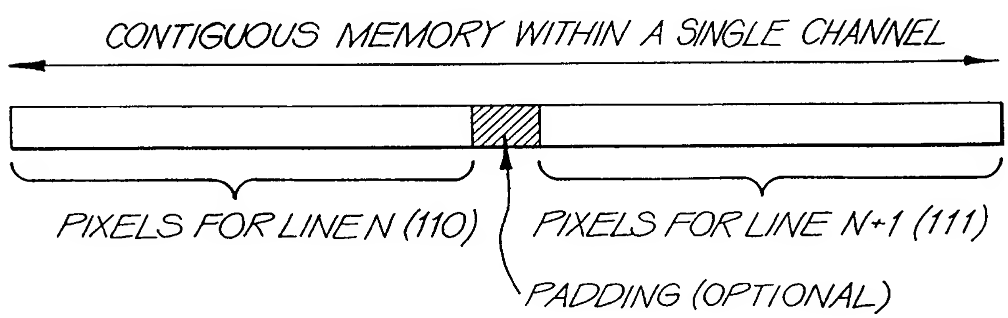


FIG. 32

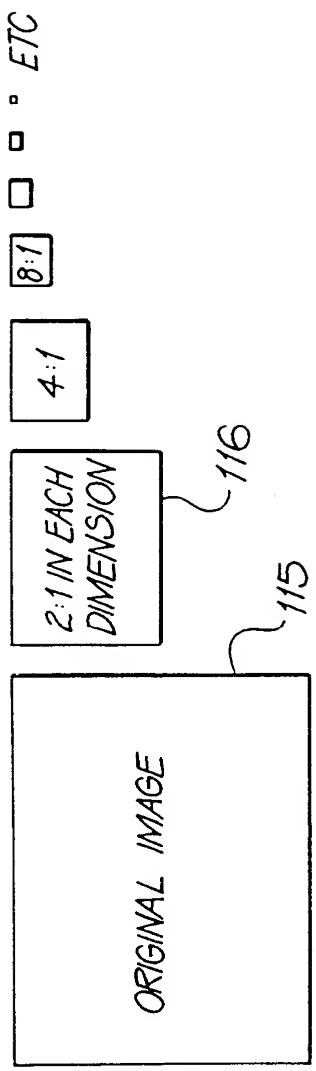


FIG. 33

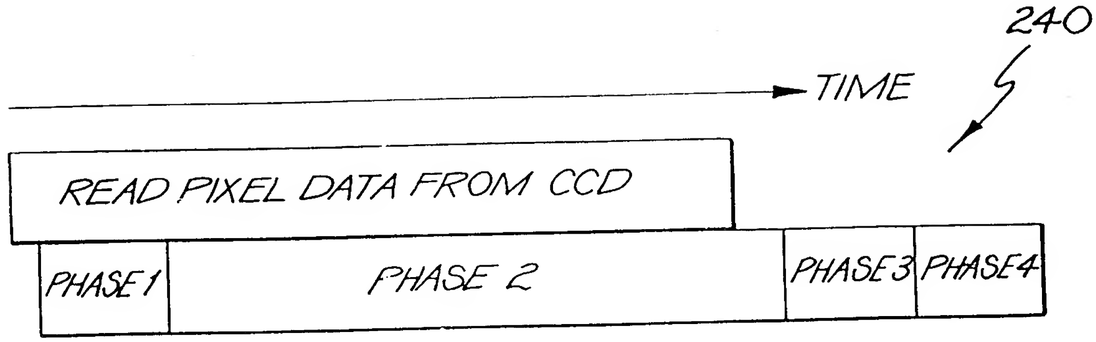

240
TIME
READ PIXEL DATA FROM CCD
PHASE 1
PHASE 2
PHASE 3
PHASE 4

FIG. 34

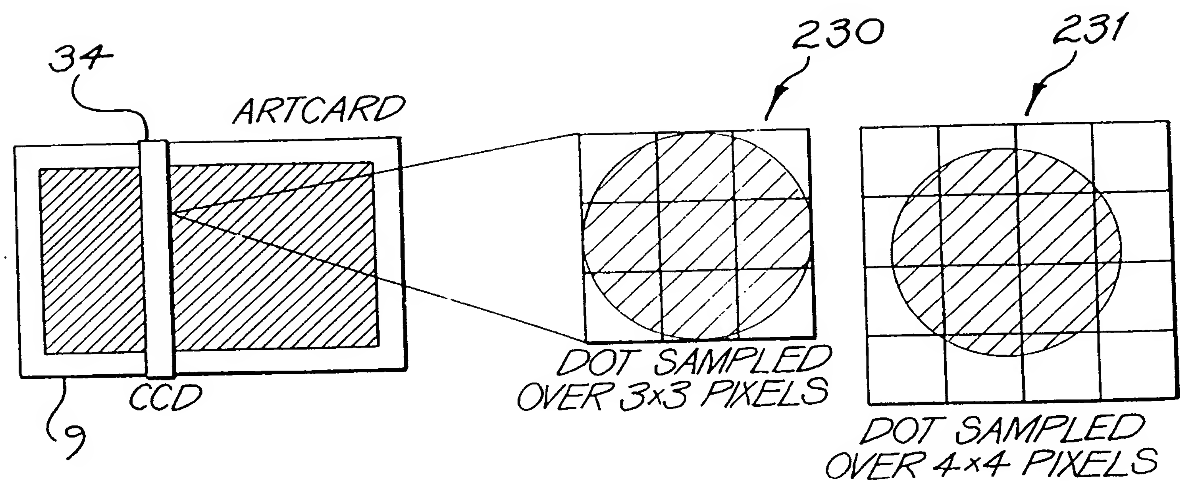

34
ARTCARD
230
231
CCD
9
DOT SAMPLED OVER 3x3 PIXELS
DOT SAMPLED OVER 4x4 PIXELS

FIG. 35

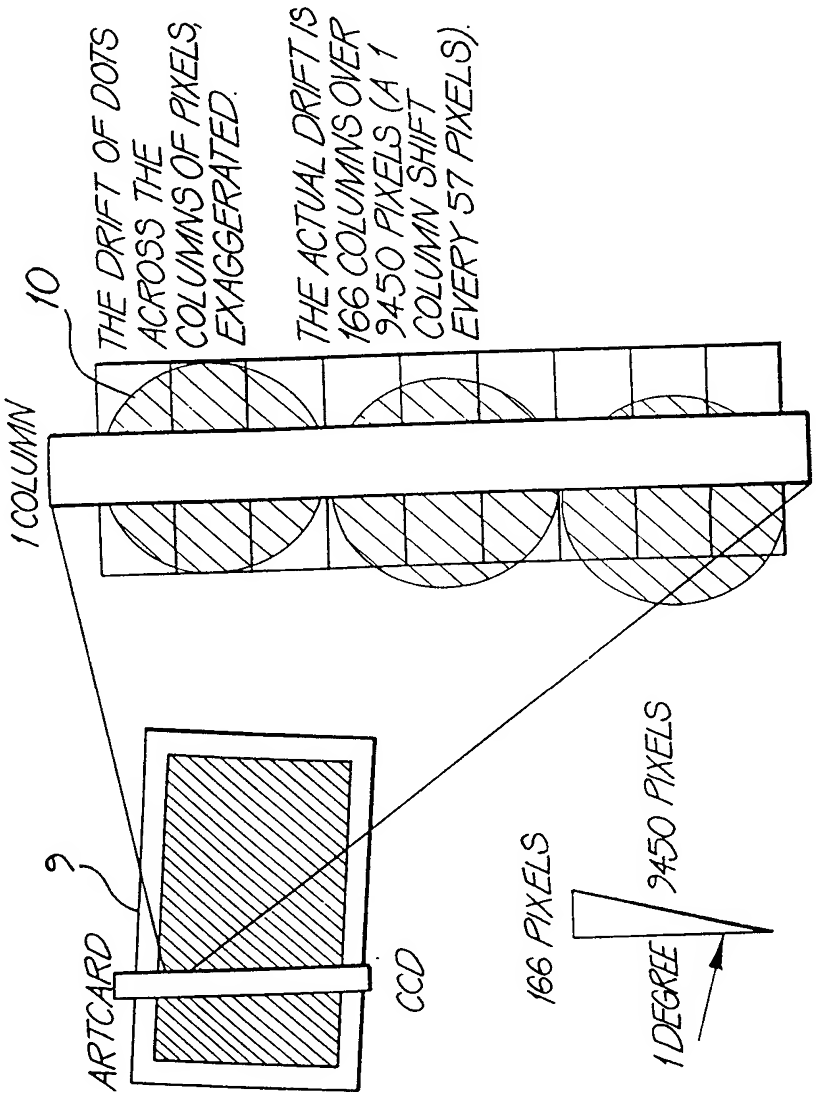

THE DRIFT OF DOTS ACROSS THE COLUMNS OF PIXELS, EXAGGERATED.
THE ACTUAL DRIFT IS 166 COLUMNS OVER 9450 PIXELS (A 1 COLUMN SHIFT EVERY 57 PIXELS).
10
1 COLUMN
9
ARTCARD
CCD
166 PIXELS
9450 PIXELS
1 DEGREE

FIG. 36

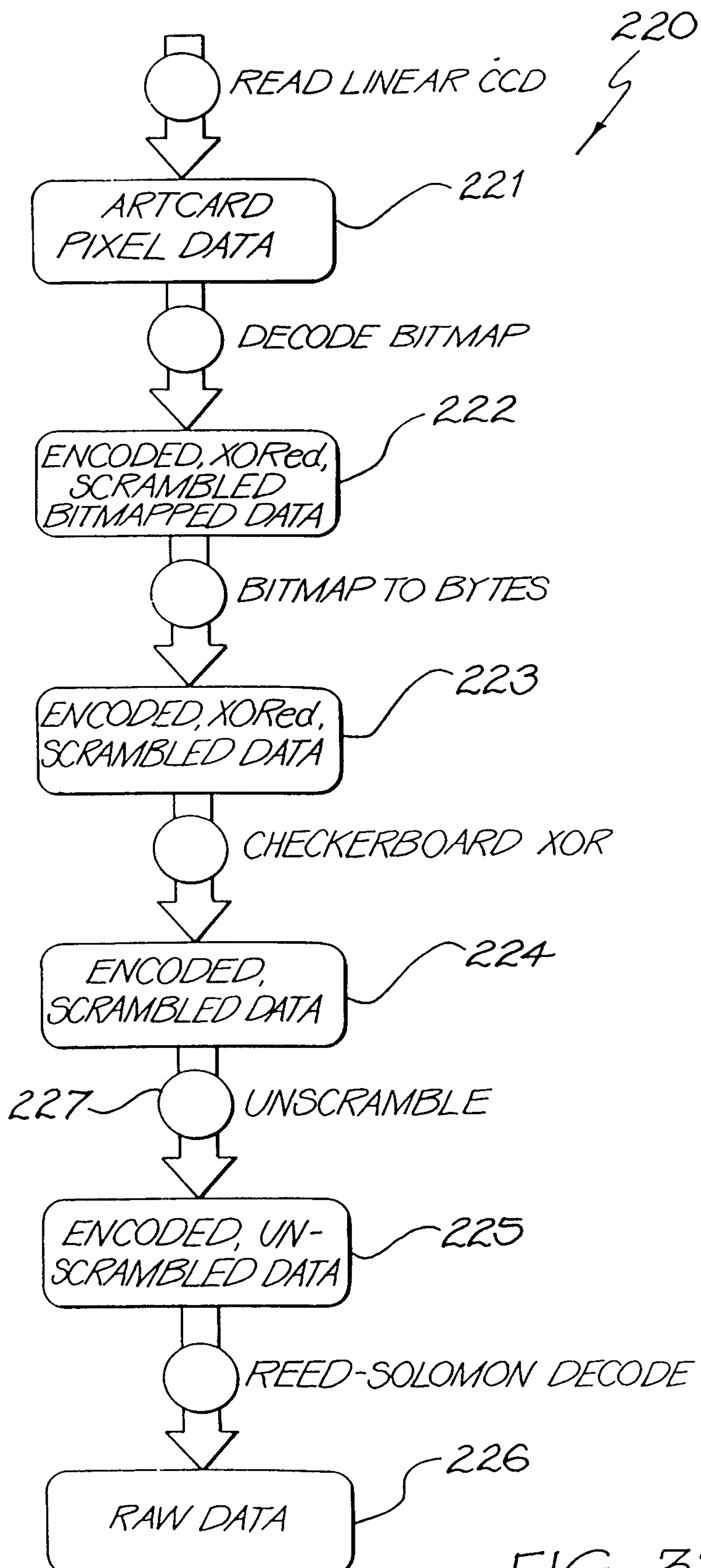
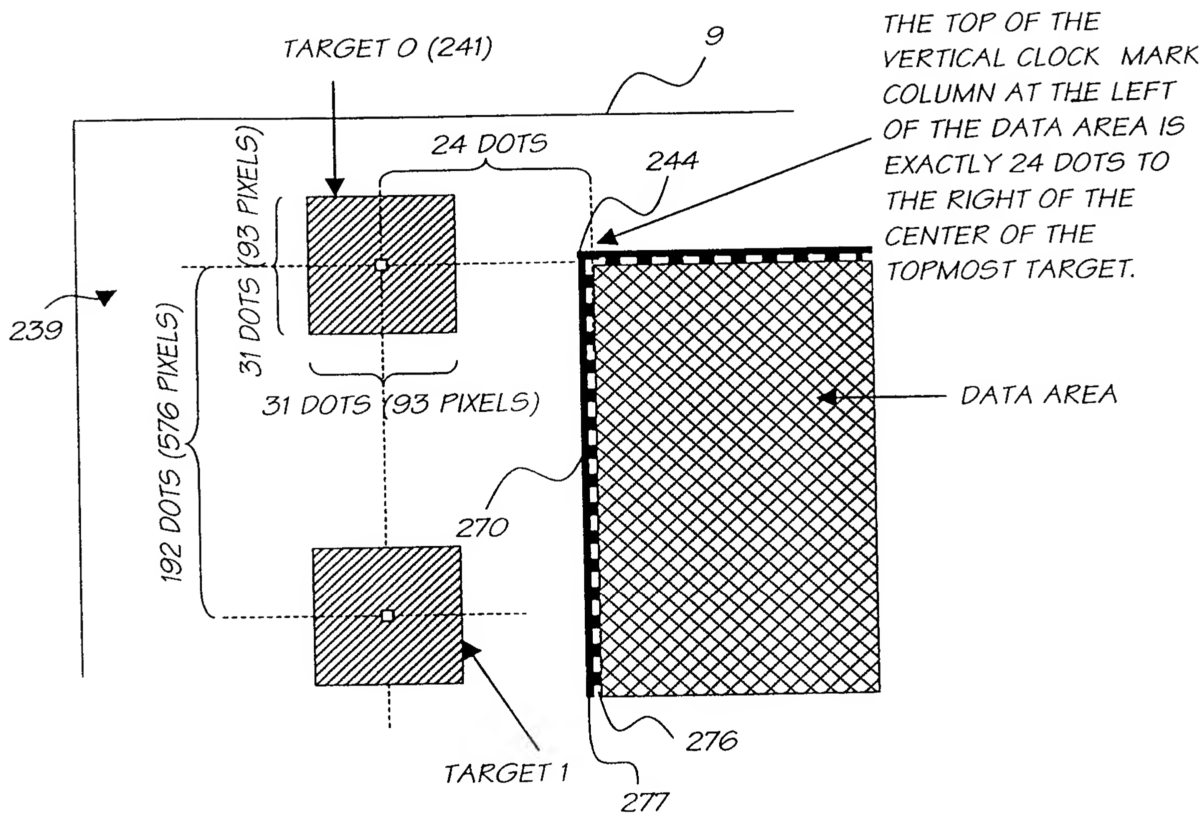

220
READ LINEAR CCD
ARTCARD PIXEL DATA
221
DECODE BITMAP
222
ENCODED, XORed, SCRAMBLED BITMAPPED DATA
BITMAP TO BYTES
223
ENCODED, XORed, SCRAMBLED DATA
CHECKERBOARD XOR
224
ENCODED, SCRAMBLED DATA
227
UNSCRAMBLE
ENCODED, UN-SCRAMBLED DATA
225
REED-SOLOMON DECODE
226
RAW DATA

FIG. 37



TARGET 0 (241)
9
THE TOP OF THE VERTICAL CLOCK MARK COLUMN AT THE LEFT OF THE DATA AREA IS EXACTLY 24 DOTS TO THE RIGHT OF THE CENTER OF THE TOPMOST TARGET.
24 DOTS
244
31 DOTS (93 PIXELS)
239
192 DOTS (576 PIXELS)
31 DOTS (93 PIXELS)
DATA AREA
270
276
TARGET 1
277

FIG. 38

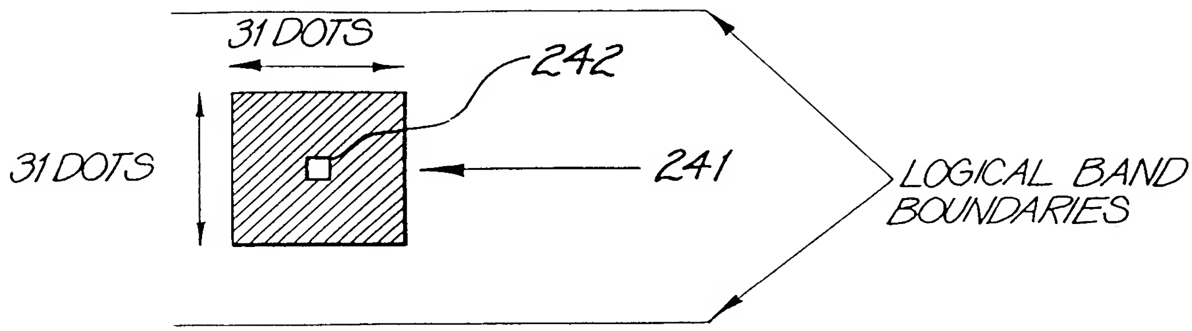

31 DOTS
242
31 DOTS
241
LOGICAL BAND BOUNDARIES

FIG. 39

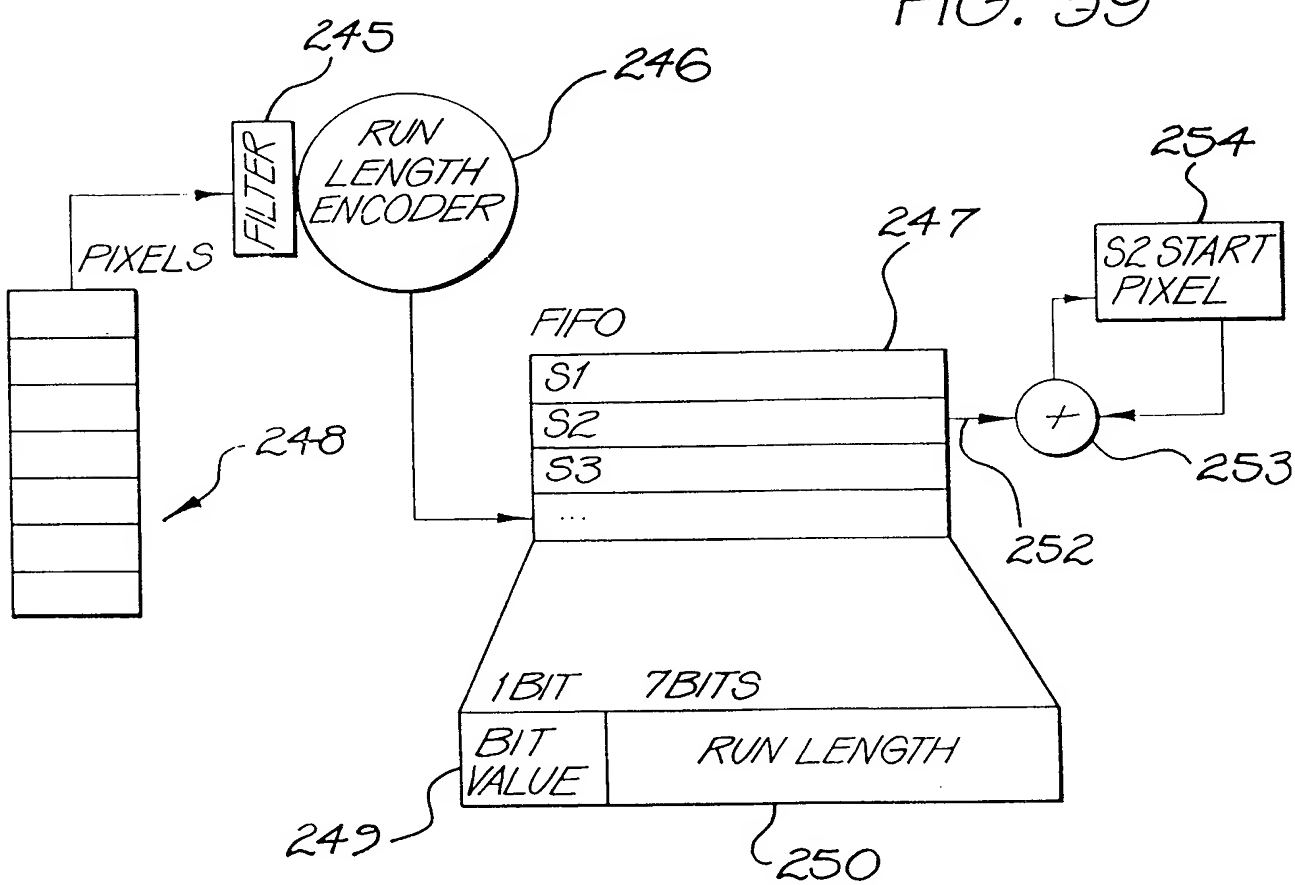

245
246
FILTER
RUN LENGTH ENCODER
PIXELS
254
S2 START PIXEL
247
FIFO
S1
S2
S3
...
248
253
252
1BIT
7BITS
BIT VALUE
RUN LENGTH
249
250

FIG. 40

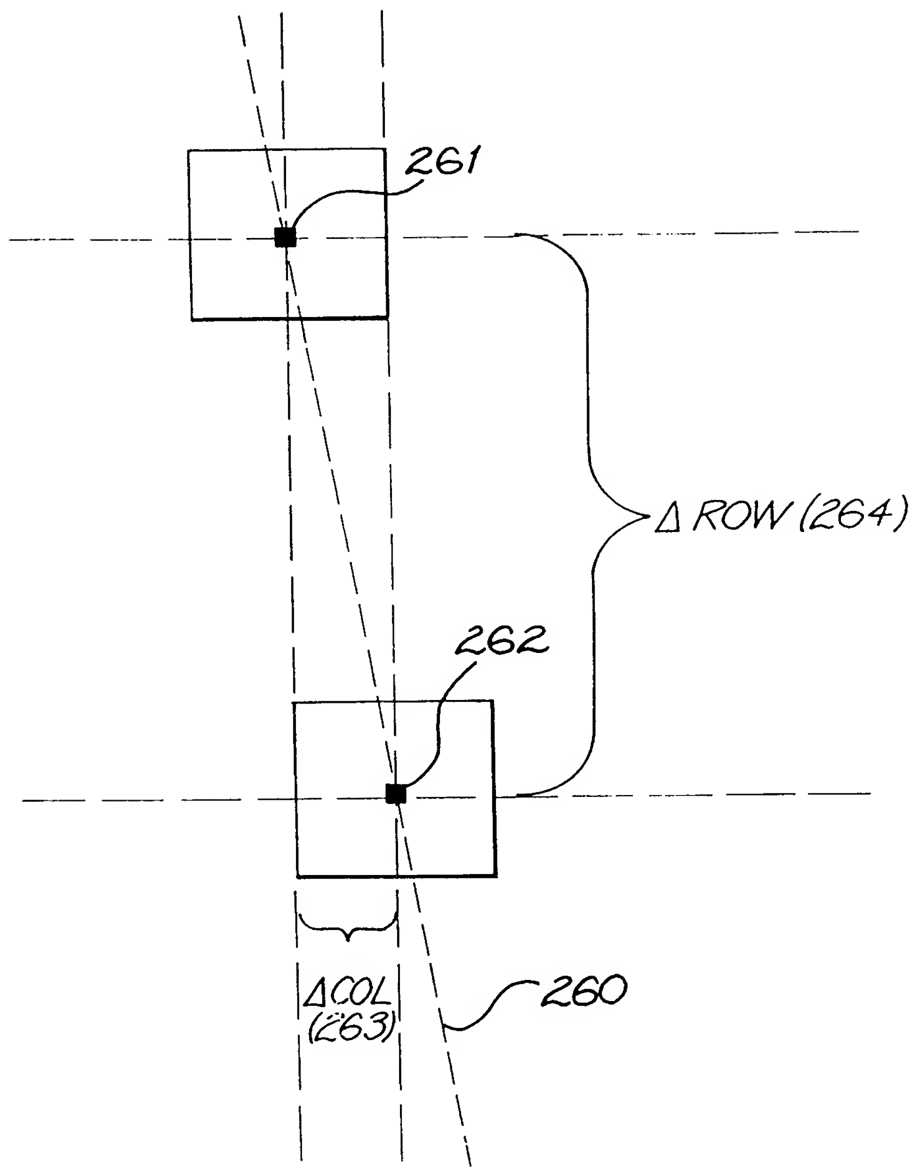


FIG. 41

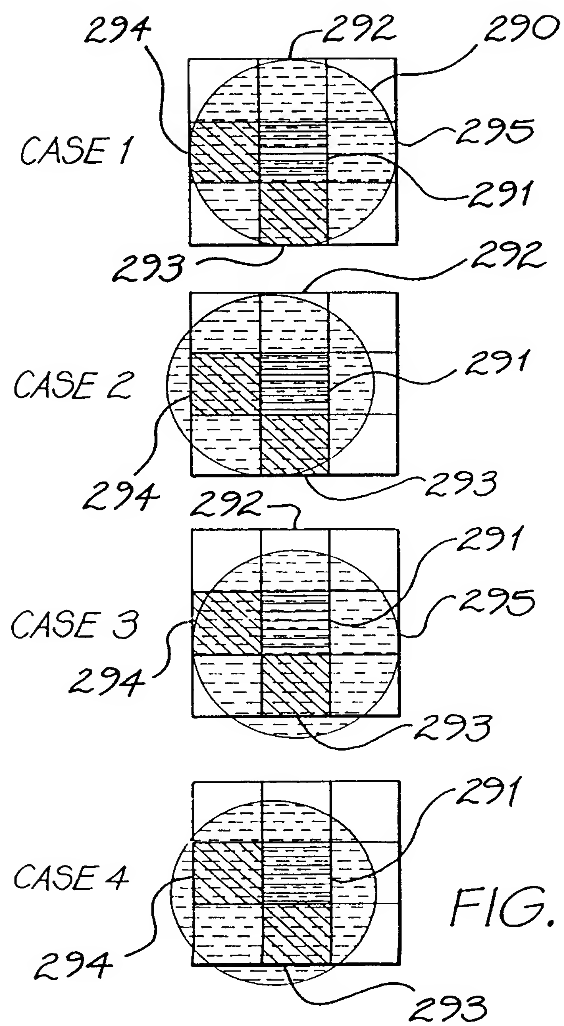
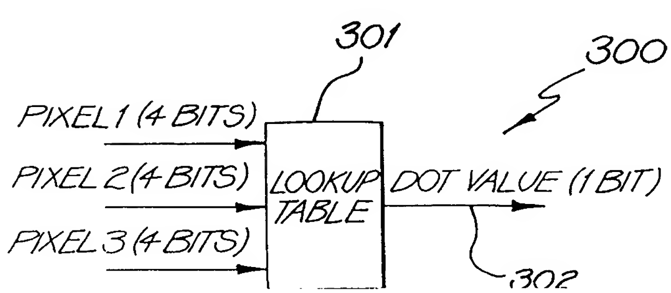

294
292
290
CASE 1
295
291
293
292
CASE 2
291
294
293
292
291
CASE 3
295
294
293
291
CASE 4
294
293

FIG. 42


301
300
PIXEL 1 (4 BITS)
PIXEL 2 (4 BITS)
PIXEL 3 (4 BITS)
LOOKUP TABLE
DOT VALUE (1 BIT)
302

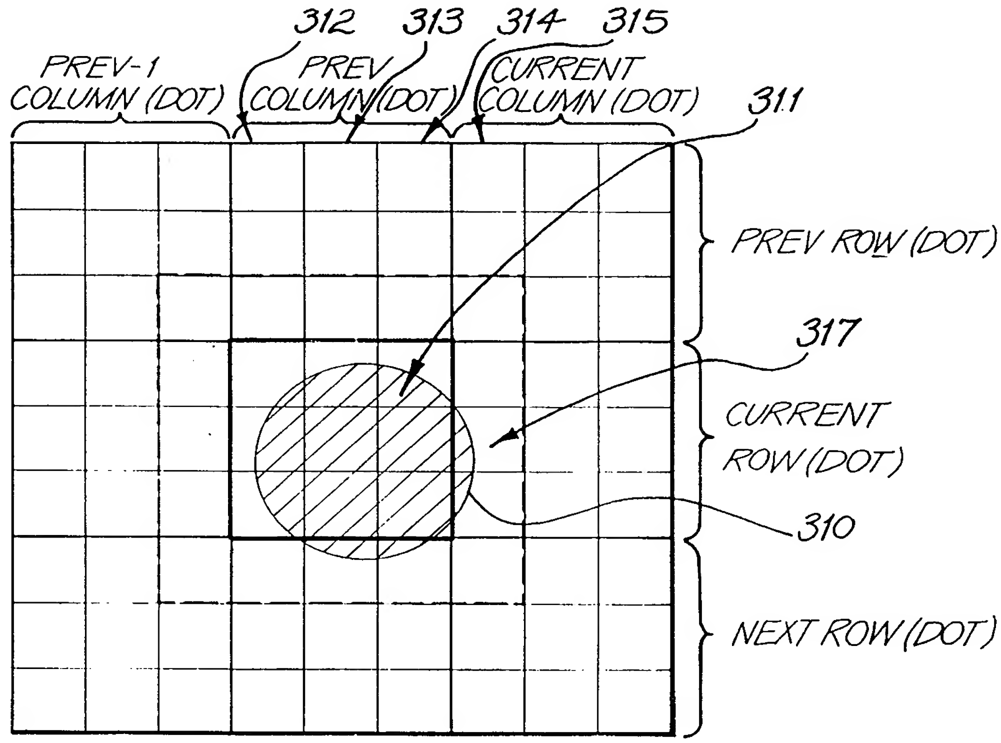
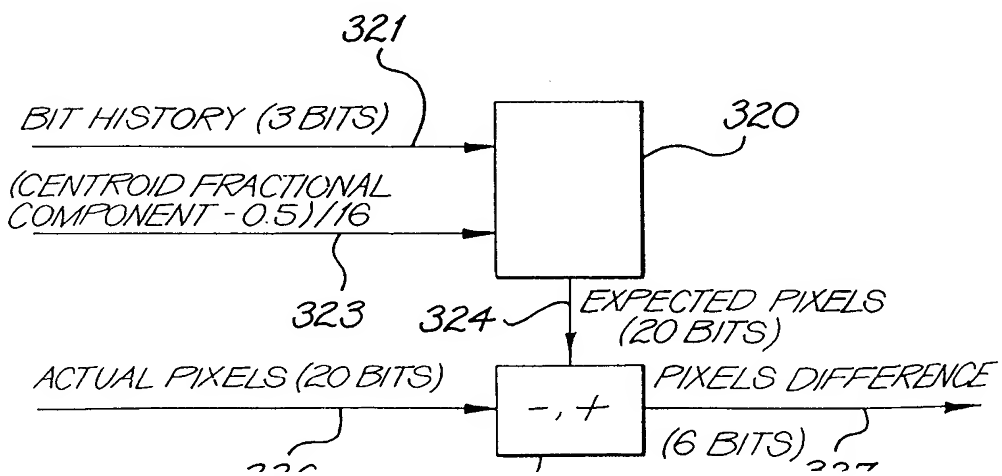

312
313
314
315
PREV-1 COLUMN (DOT)
PREV COLUMN (DOT)
CURRENT COLUMN (DOT)
311
PREV ROW (DOT)
317
CURRENT ROW (DOT)
310
NEXT ROW (DOT)

FIG. 44


321
BIT HISTORY (3 BITS)
320
(CENTROID FRACTIONAL COMPONENT - 0.5)/16
323
324
EXPECTED PIXELS (20 BITS)
ACTUAL PIXELS (20 BITS)
-, +
PIXELS DIFFERENCE
(6 BITS)

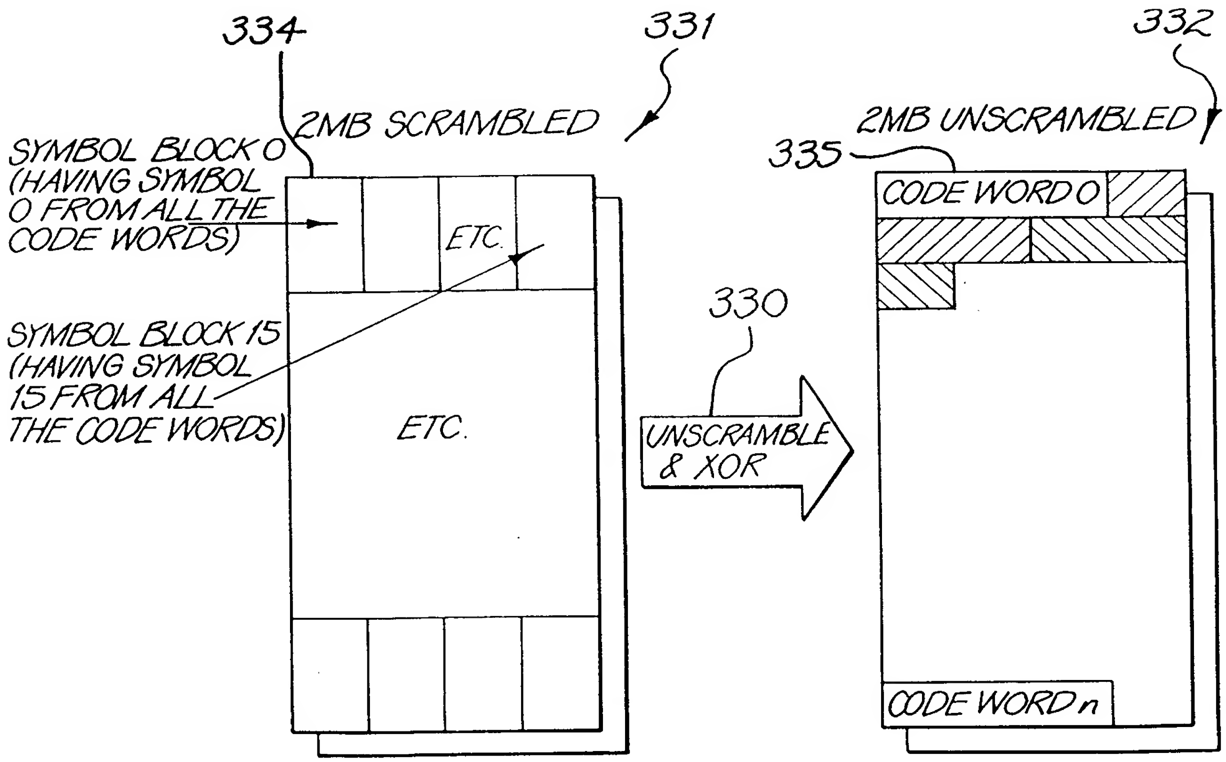

334
331
332
2MB SCRAMBLED
2MB UNSCRAMBLED
SYMBOL BLOCK 0 (HAVING SYMBOL 0 FROM ALL THE CODE WORDS)
SYMBOL BLOCK 15 (HAVING SYMBOL 15 FROM ALL THE CODE WORDS)
ETC.
ETC.
330
UNSCRAMBLE & XOR
335
CODE WORD 0
CODE WORD n

FIG. 46

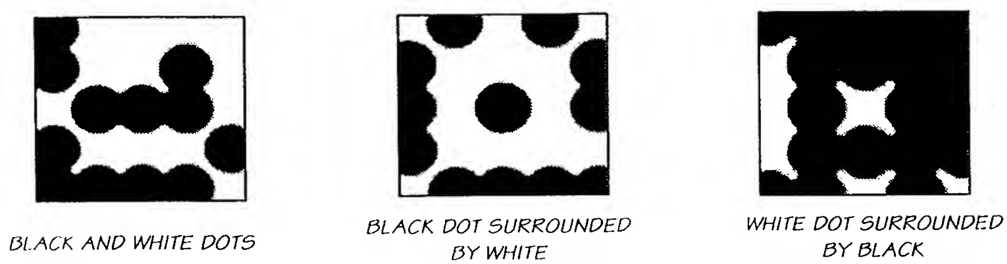

BLACK AND WHITE DOTS
BLACK DOT SURROUNDED BY WHITE
WHITE DOT SURROUNDED BY BLACK

FIG. 47

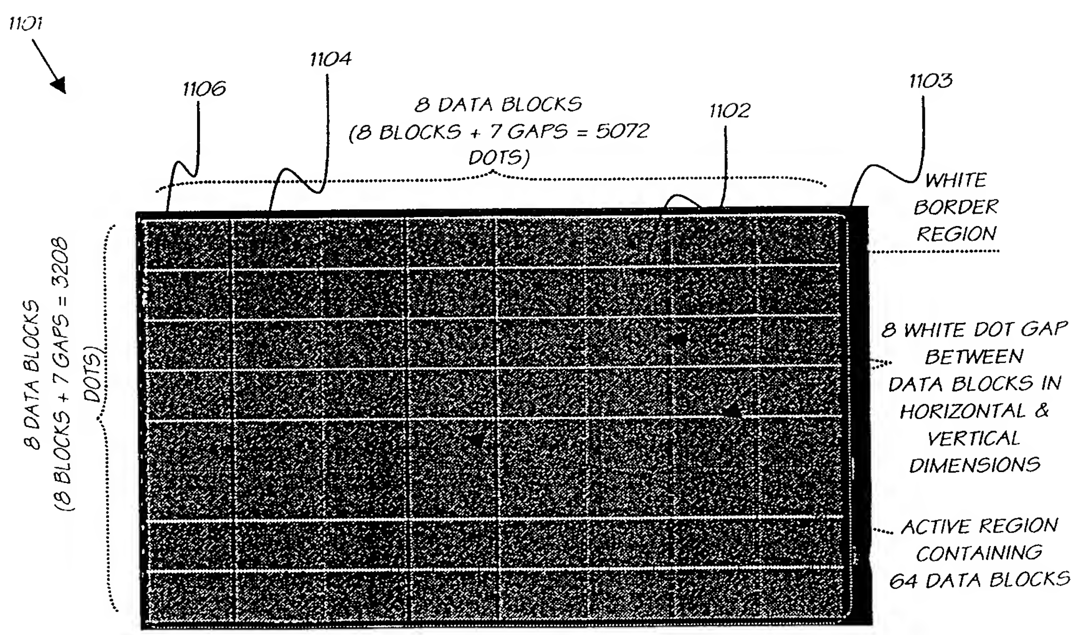
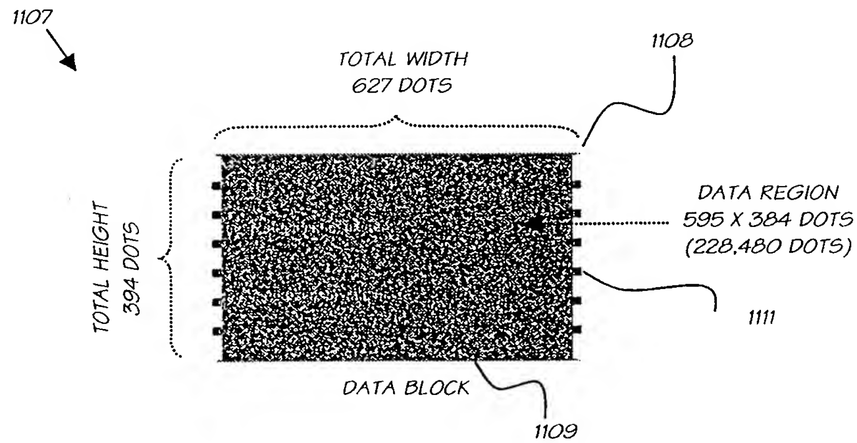
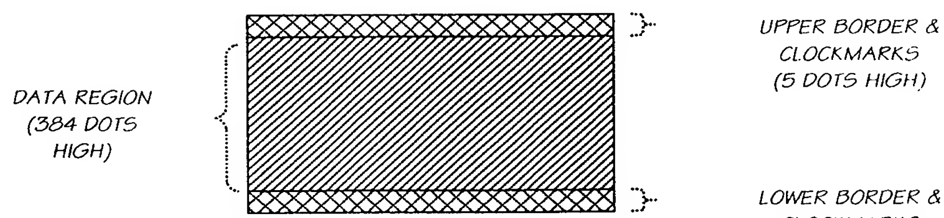
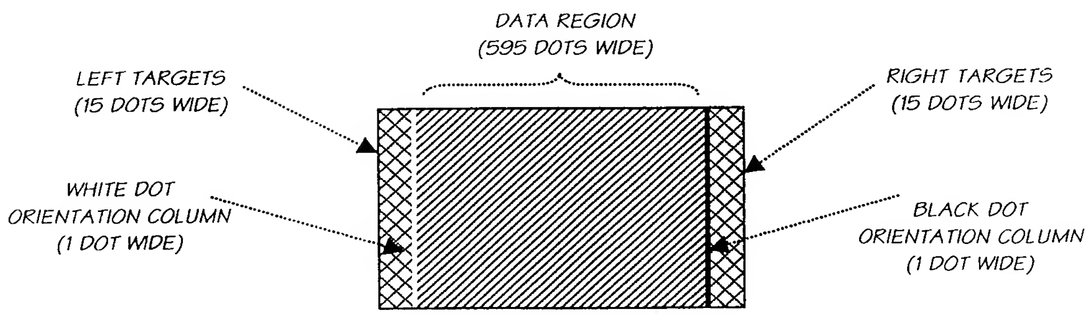

1101
1106
1104
8 DATA BLOCKS
(8 BLOCKS + 7 GAPS = 5072 DOTS)
1102
1103
WHITE BORDER REGION
8 DATA BLOCKS
(8 BLOCKS + 7 GAPS = 3208 DOTS)
8 WHITE DOT GAP BETWEEN DATA BLOCKS IN HORIZONTAL & VERTICAL DIMENSIONS
ACTIVE REGION CONTAINING 64 DATA BLOCKS

FIG. 48





VERTICAL STRUCTURE OF DATA BLOCK



HORIZONTAL STRUCTURE OF DATA BLOCK

FIG. 49

FIG. 51

UPPER LEFT CLOCKMARKS AND BORDER

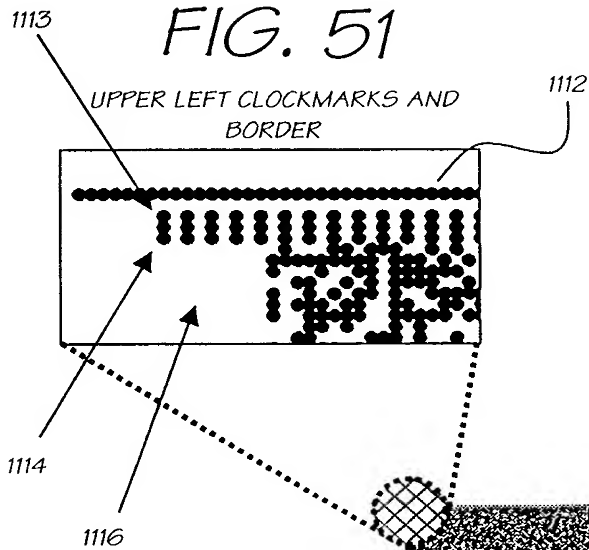
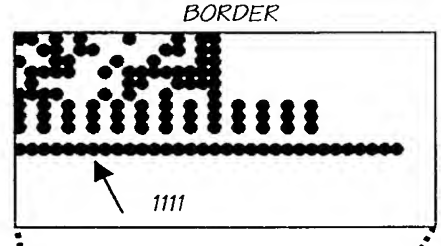


FIG. 52

LOWER RIGHT CLOCKMARKS AND BORDER



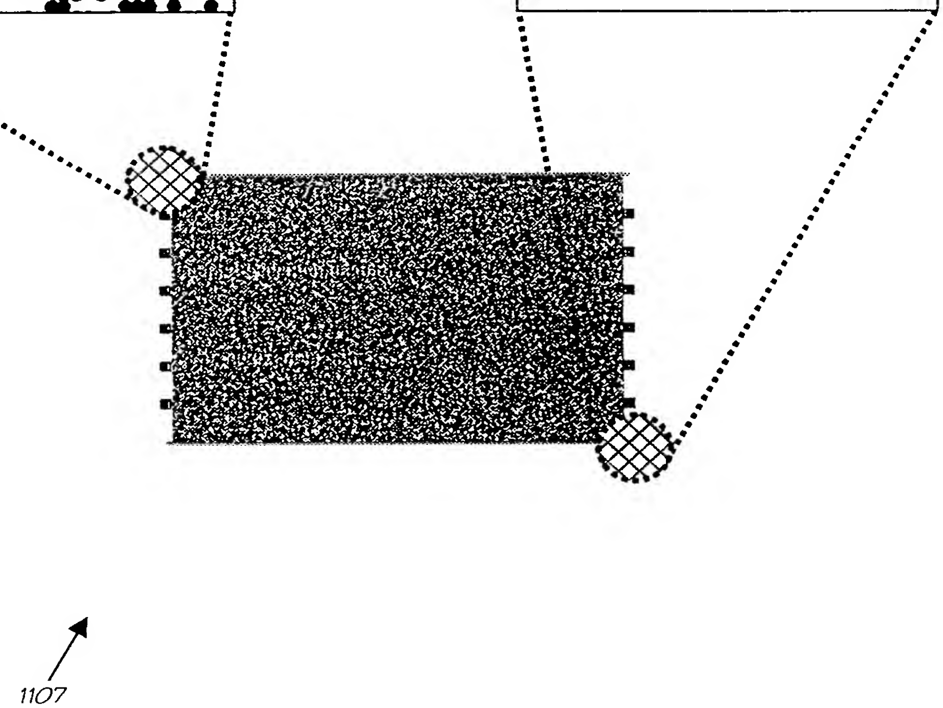


FIG. 50

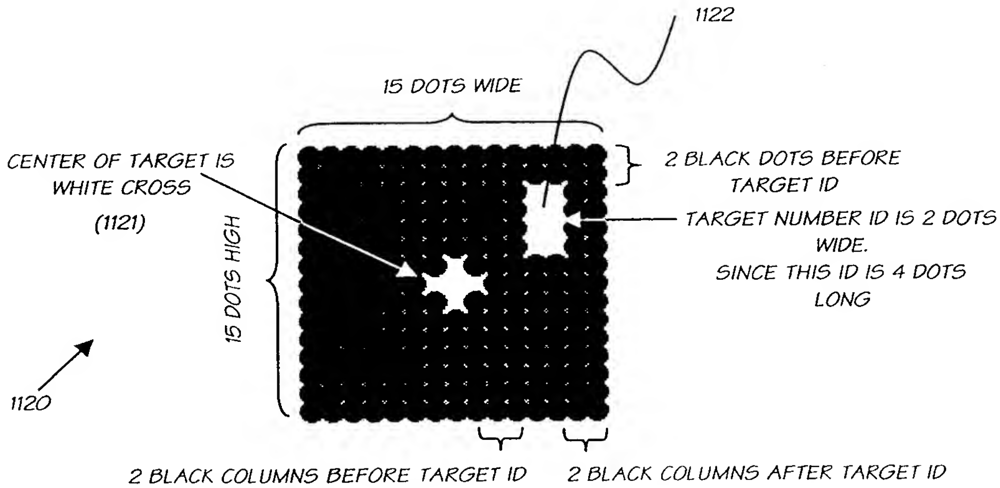

1122
15 DOTS WIDE
CENTER OF TARGET IS WHITE CROSS
(1121)
2 BLACK DOTS BEFORE TARGET ID
TARGET NUMBER ID IS 2 DOTS WIDE.
SINCE THIS ID IS 4 DOTS LONG
15 DOTS HIGH
1120
2 BLACK COLUMNS BEFORE TARGET ID
2 BLACK COLUMNS AFTER TARGET ID

FIG. 53

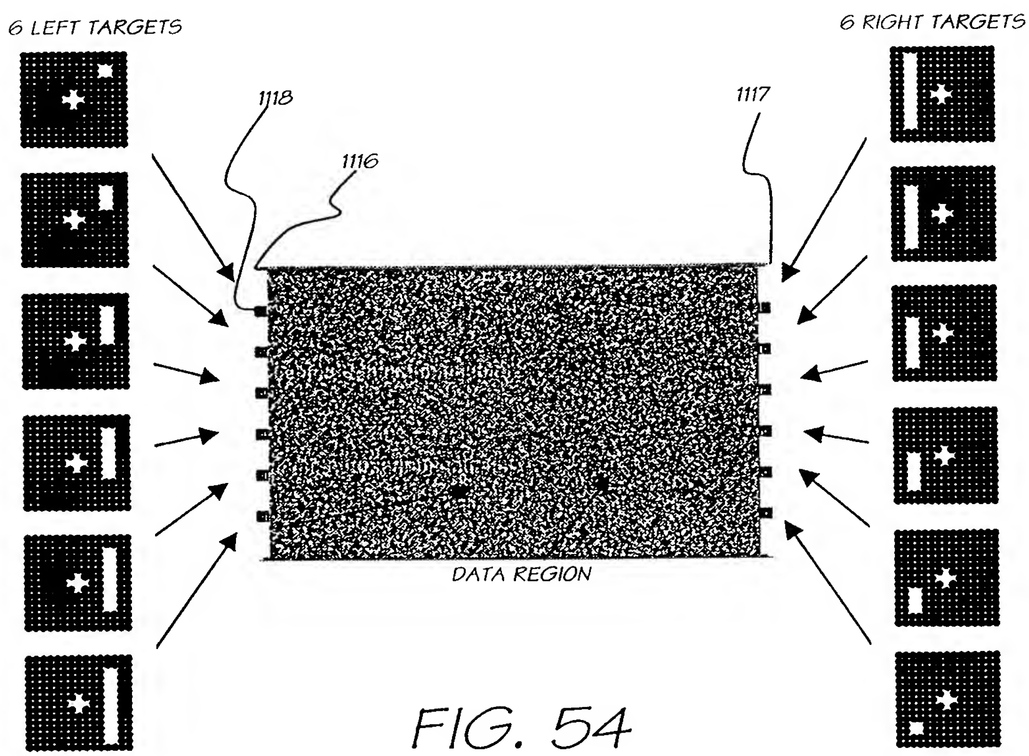

6 LEFT TARGETS
6 RIGHT TARGETS
1118
1117
1116
DATA REGION

FIG. 54

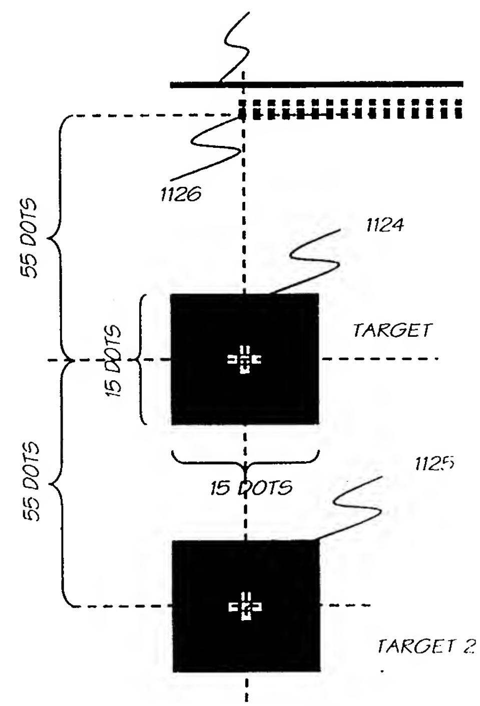
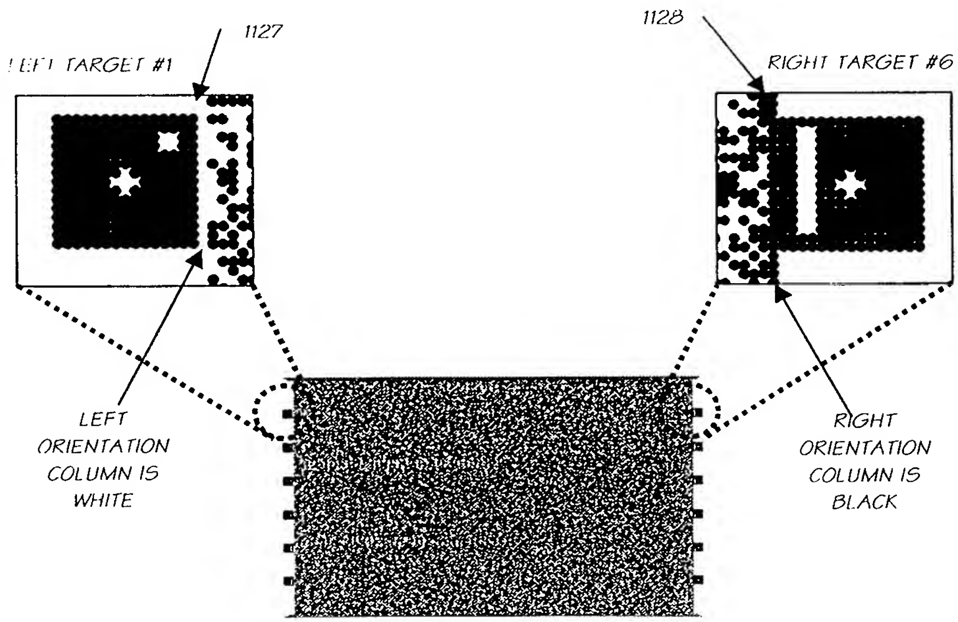

1123
1126
1124
55 DOTS
TARGET
15 DOTS
15 DOTS
1125
55 DOTS
TARGET 2

FIG. 55


1127
1128
LEFT TARGET #1
RIGHT TARGET #6
LEFT ORIENTATION COLUMN IS WHITE
RIGHT ORIENTATION COLUMN IS BLACK

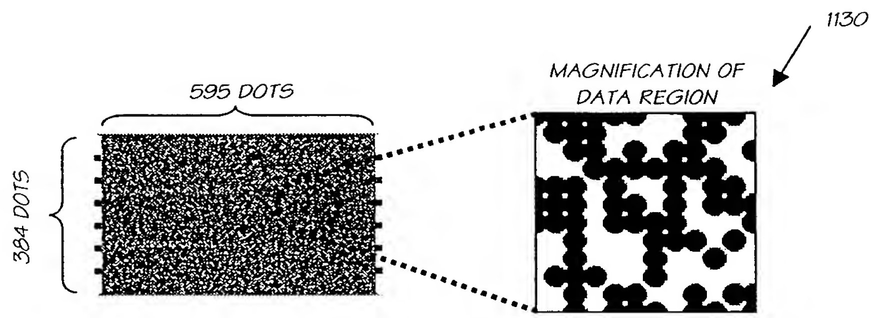


FIG. 57

00:	4F	00	3D	4F	00	3D	4F	00	3D	4F	00	3D	32 COPIES OF THE 3 BYTE CONTROL INFORMATION
0C:	4F	00	3D	4F	00	3D	4F	00	3D	4F	00	3D	
18:	4F	00	3D	4F	00	3D	4F	00	3D	4F	00	3D	
24:	4F	00	3D	4F	00	3D	4F	00	3D	4F	00	3D	
30:	4F	00	3D	4F	00	3D	4F	00	3D	4F	00	3D	
3C:	4F	00	3D	4F	00	3D	4F	00	3D	4F	00	3D	
48:	4F	00	3D	4F	00	3D	4F	00	3D	4F	00	3D	
54:	4F	00	3D	4F	00	3D	4F	00	3D	4F	00	3D	
60:	00	00	00	00	00	00	00	00	00	00	00	00	RESERVED BYTES ARE 0
6C:	00	00	00	00	00	00	00	00	00	00	00	00	
78:	00	00	00	00	00	00	00	00	00	00	00		

FIG. 59

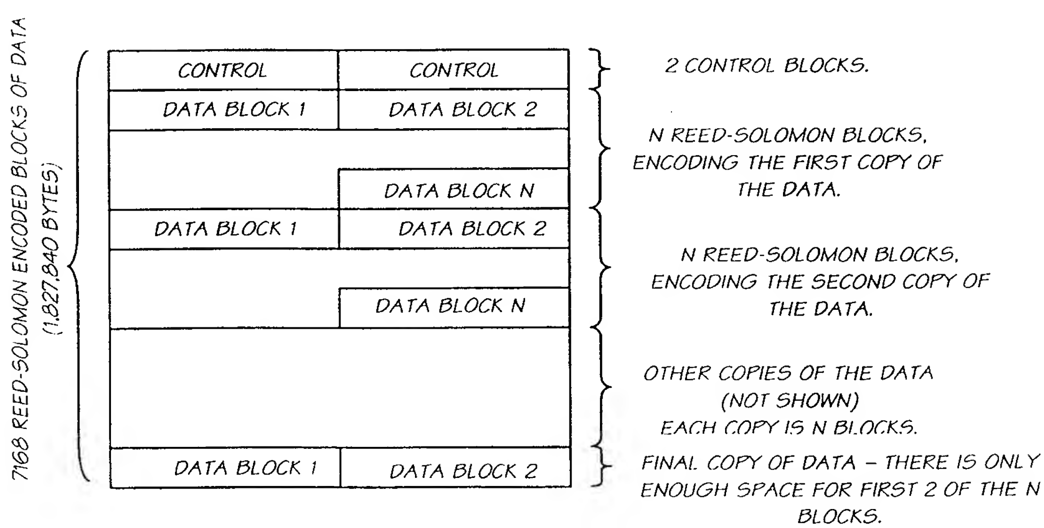


FIG. 58

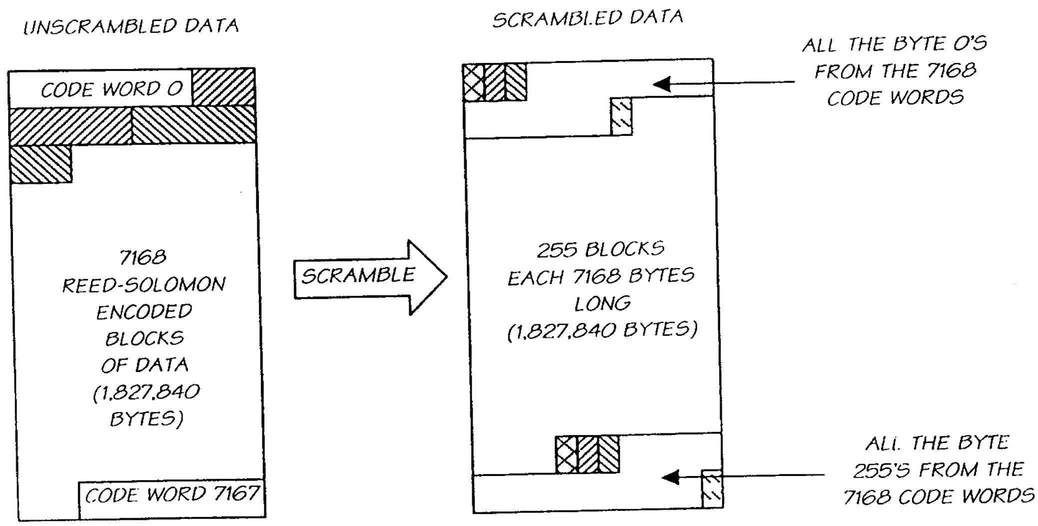


FIG. 60

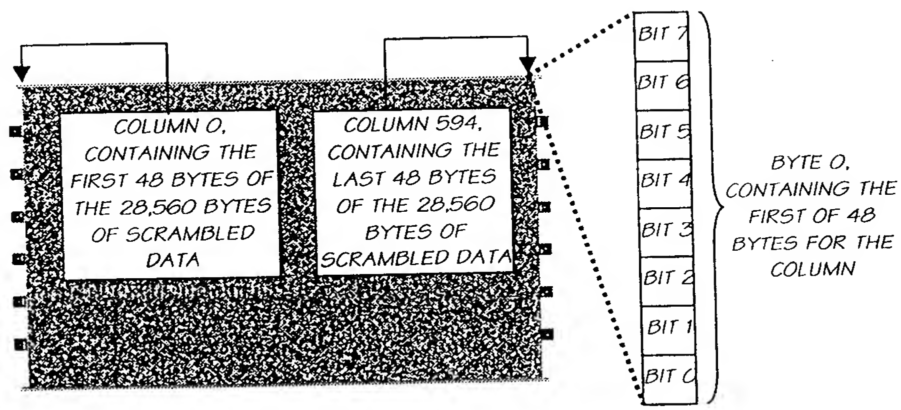


FIG. 61

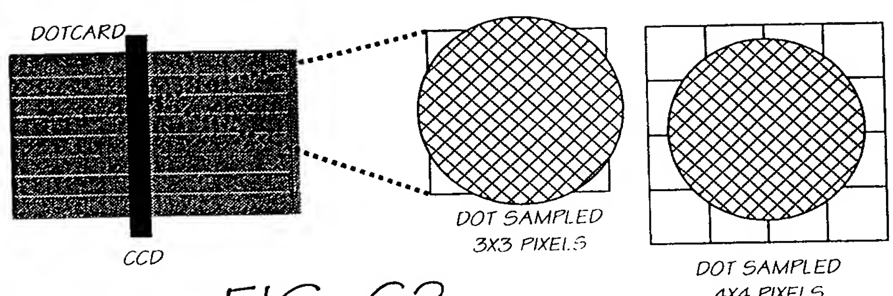


FIG. 62

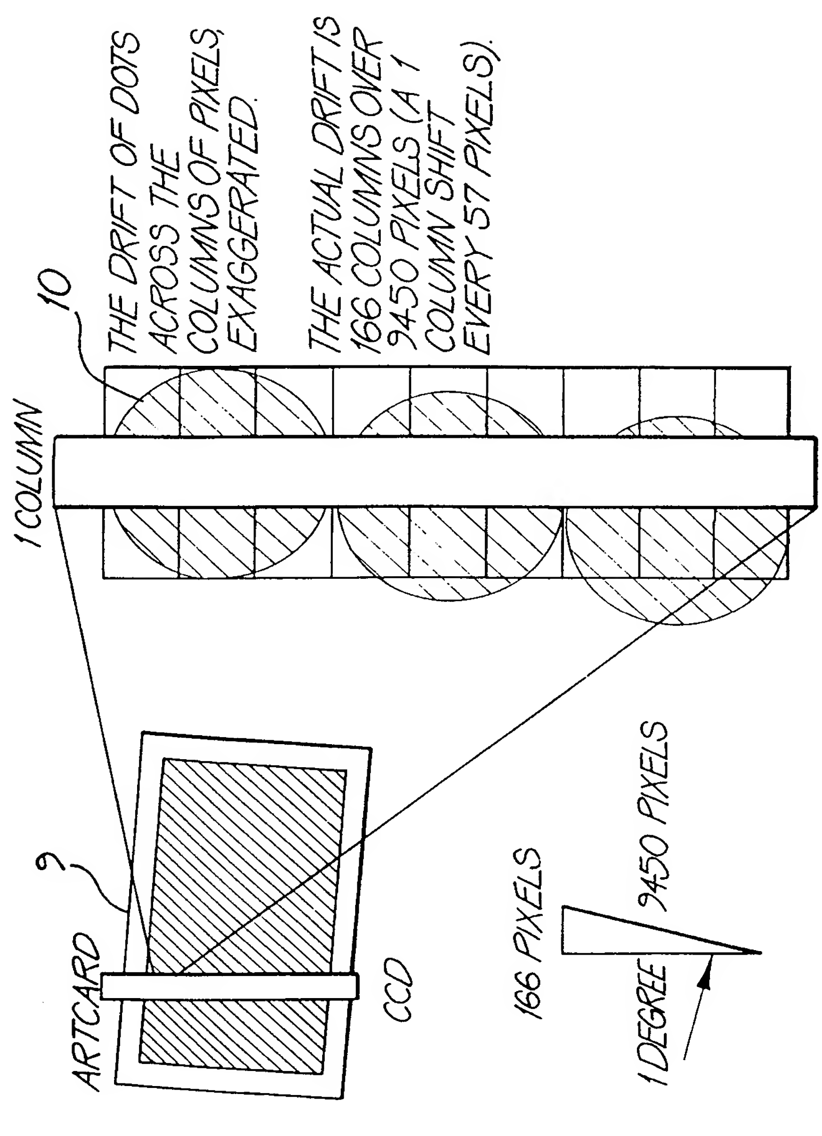

THE DRIFT OF DOTS ACROSS THE COLUMNS OF PIXELS, EXAGGERATED.
THE ACTUAL DRIFT IS 166 COLUMNS OVER 9450 PIXELS (A 1 COLUMN SHIFT EVERY 57 PIXELS).
10
1 COLUMN
9
ARTCARD
CCD
166 PIXELS
9450 PIXELS
1 DEGREE

FIG. 63

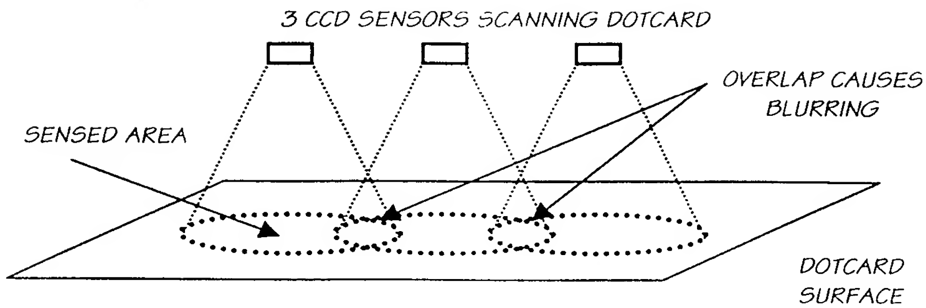

3 CCD SENSORS SCANNING DOTCARD
OVERLAP CAUSES BLURRING
SENSED AREA
DOTCARD SURFACE

FIG. 64

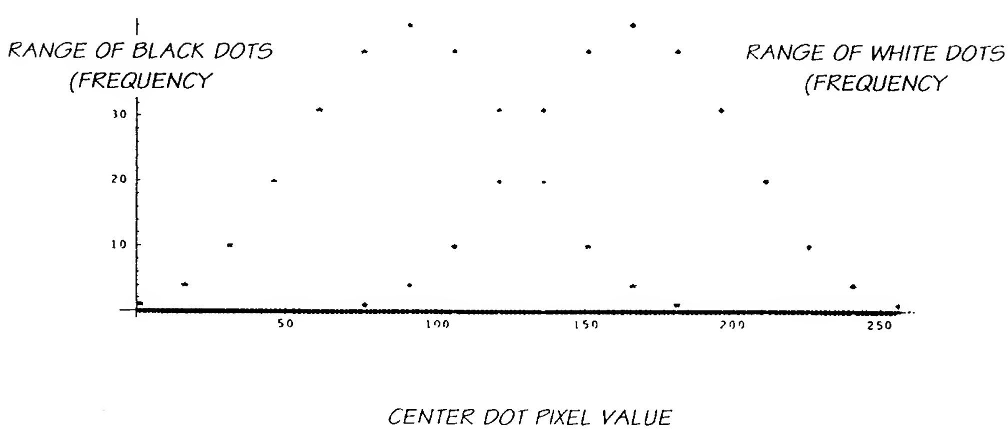

RANGE OF BLACK DOTS (FREQUENCY
RANGE OF WHITE DOTS (FREQUENCY
30
20
10
50
100
150
200
250
CENTER DOT PIXEL VALUE

FIG. 65

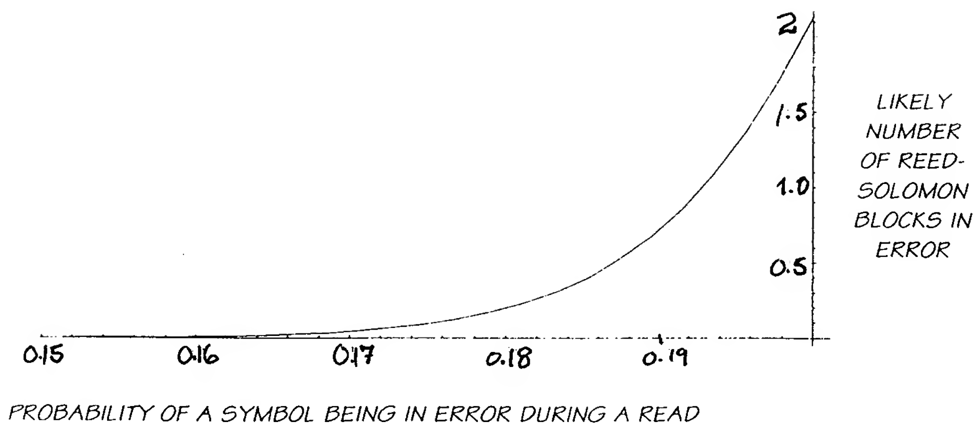
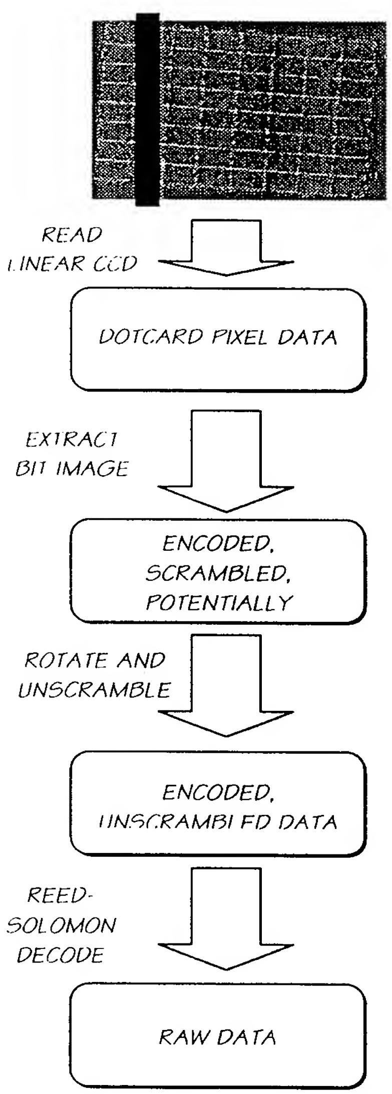


FIG. 66



APPROXIMATE DATA SIZES FOR 1600 DPI DOTCARD

86MM + 1MM IN HORIZONTAL DIMENSION FOR 1° ROTATION = 87MM
87MM = 16,252 SCANLINES
16,440 SCANLINES @ 11,000 PIXELS PER SCANLINE = 180,840,000 PIXELS
180,840,000 PIXELS @ 1 BYTE PER PIXEL = 180,840,000 BYTES = 172.5 MB

64 DATA BLOCKS, EACH CONTAINING 597 COLUMNS (595 DATA REGION COLUMNS AND 2 ORIENTATION COLUMNS), @ 48 BYTES PER COLUMN = 28,656 BYTES PER DATA BLOCK FOR A TOTAL OF 1,833,984 BYTES.

64 DATA BLOCKS, EACH CONTAINING 112 ENCODED REED SOLOMON BLOCKS, @ 255 BYTES PER REED SOLOMON BLOCK FOR A TOTAL OF 1,827,840 BYTES.

DECODED DATA, WITH A MAXIMUM SIZE OF 910,082 BYTES. (64 X 112 X 127 - (2 CONTROL BLOCKS @ 127 BYTES))

FIG. 67

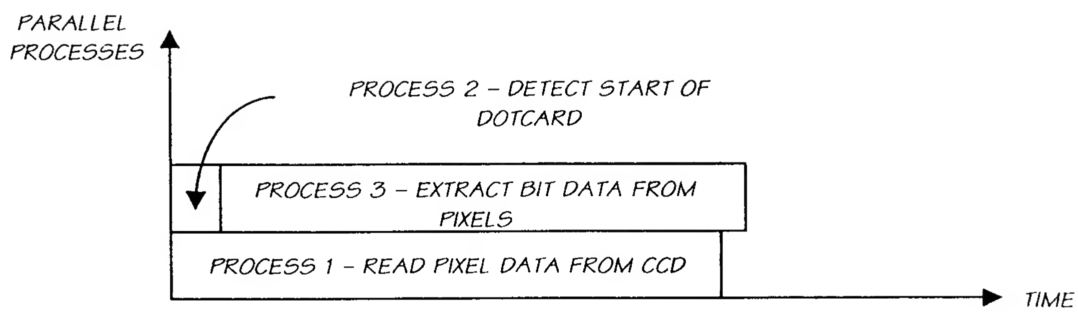

PARALLEL PROCESSES
PROCESS 2 - DETECT START OF DOTCARD
PROCESS 3 - EXTRACT BIT DATA FROM PIXELS
PROCESS 1 - READ PIXEL DATA FROM CCD
TIME

FIG. 68

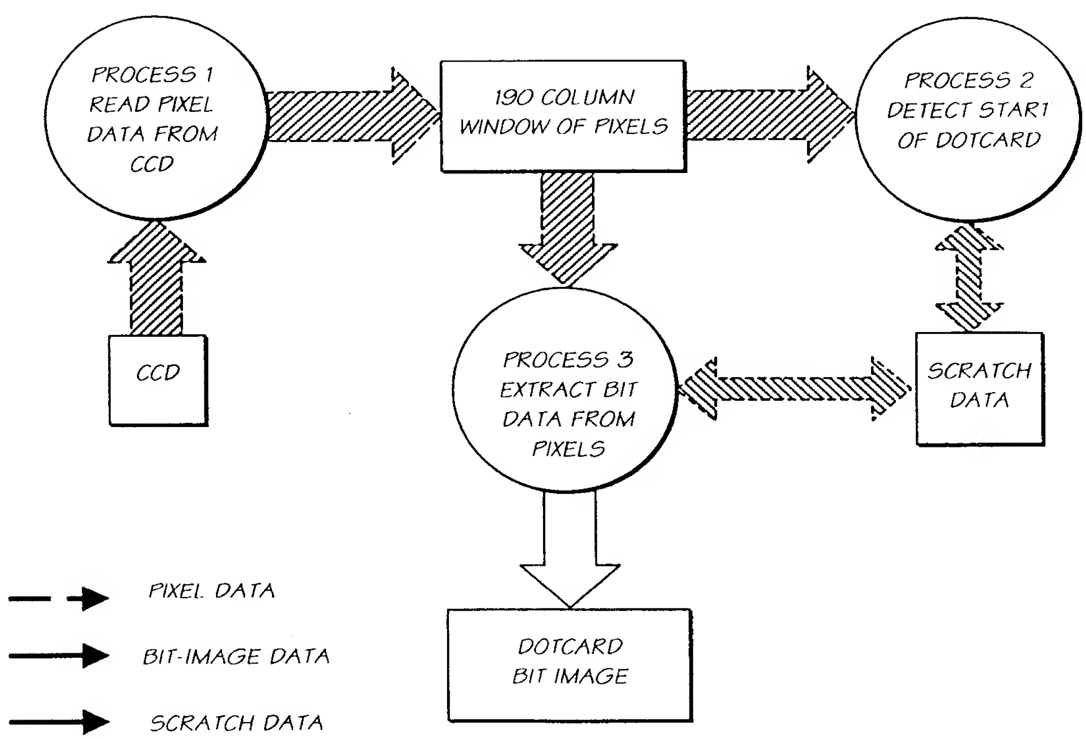

PROCESS 1 READ PIXEL DATA FROM CCD
190 COLUMN WINDOW OF PIXELS
PROCESS 2 DETECT START OF DOTCARD
CCD
PROCESS 3 EXTRACT BIT DATA FROM PIXELS
SCRATCH DATA
DOTCARD BIT IMAGE
PIXEL DATA
BIT-IMAGE DATA
SCRATCH DATA

FIG. 69

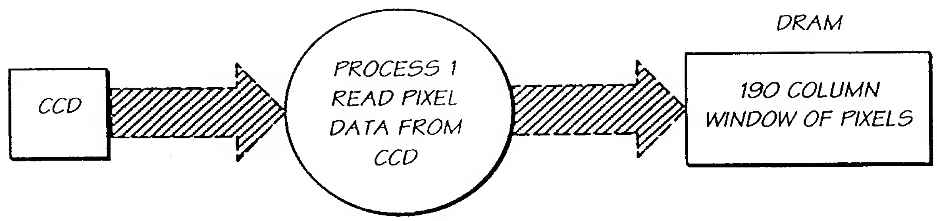


FIG. 70

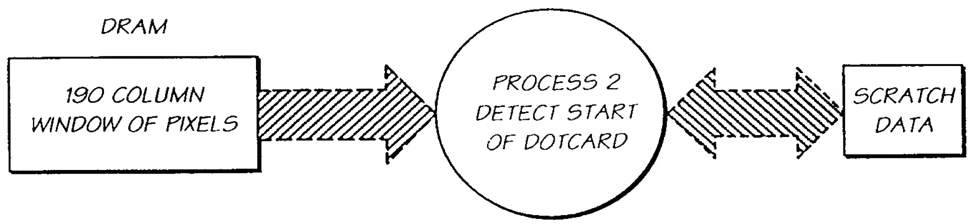


FIG. 71

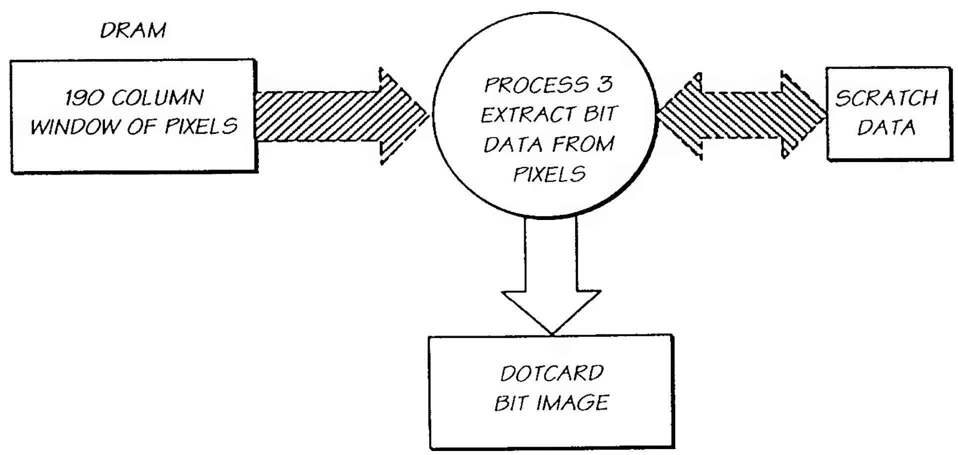


FIG. 72

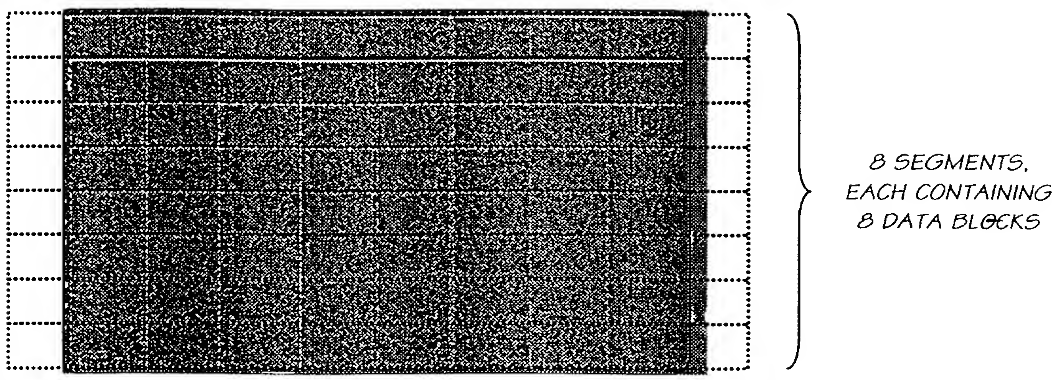

8 SEGMENTS,
EACH CONTAINING
8 DATA BLOCKS

FIG. 73

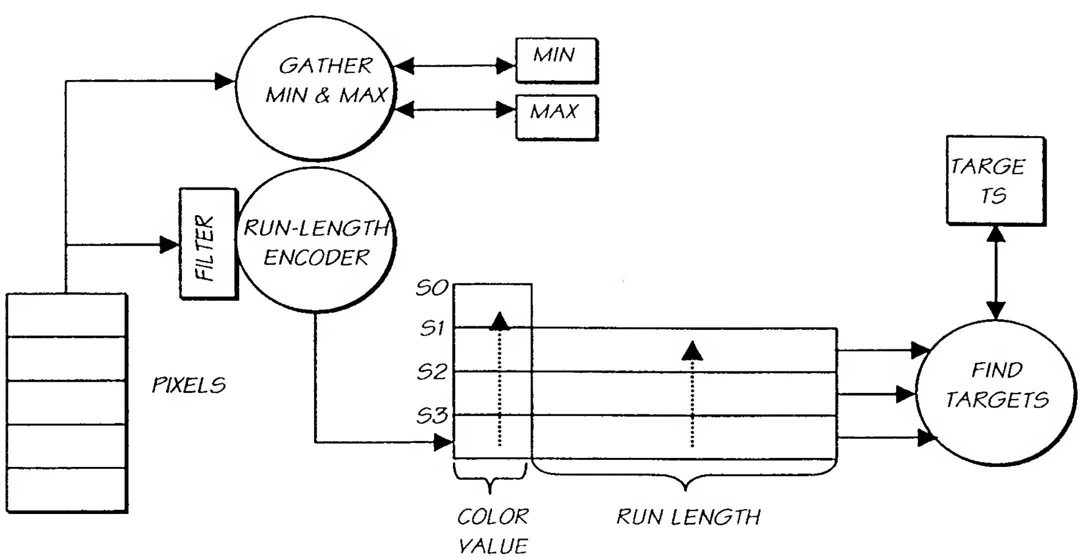

GATHER
MIN & MAX
MIN
MAX
TARGE
TS
FILTER
RUN-LENGTH
ENCODER
S0
S1
S2
S3
PIXELS
FIND
TARGETS
COLOR
VALUE
RUN LENGTH

FIG. 74

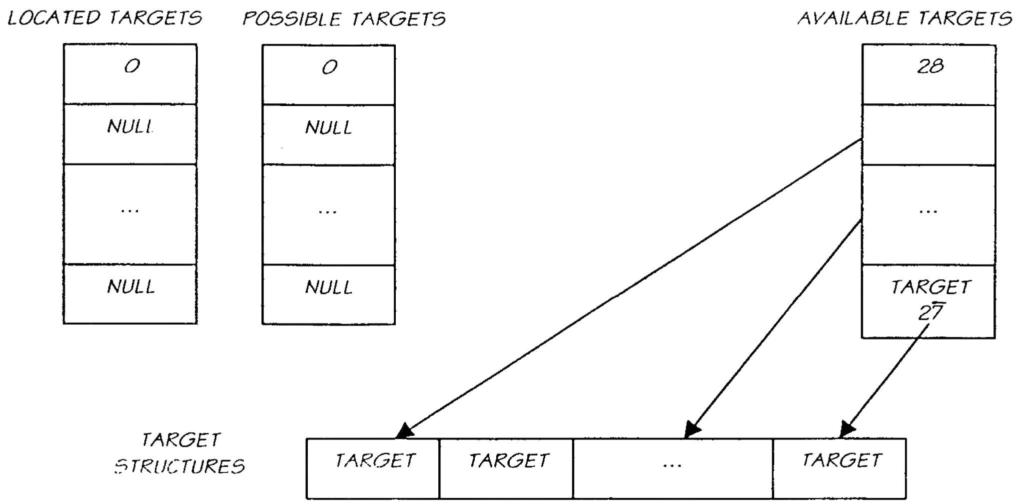
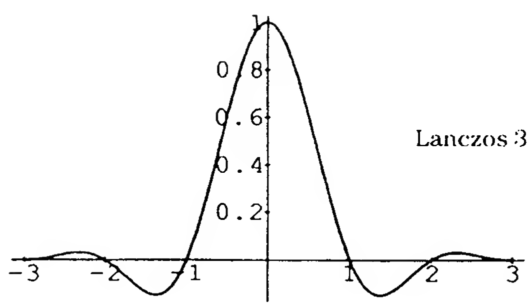


FIG. 75



$$\mathrm{Lanczos}3(x) = \begin{cases} \dfrac{\sin(\pi x)}{\pi x} \dfrac{\sin\left(\pi \frac{x}{3}\right)}{\pi \frac{x}{3}}, & |x| < 3 \\ 0, & |x| \geq 3 \end{cases}$$

FIG. 76

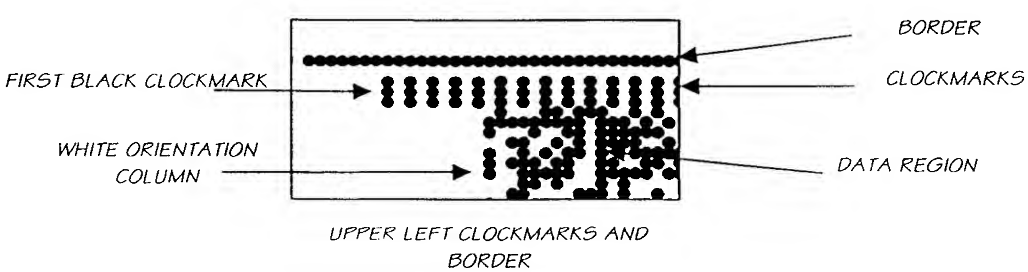


FIG. 77

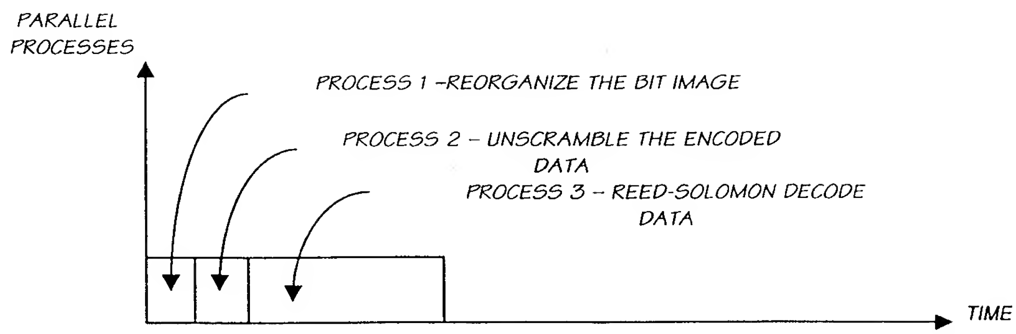

PARALLEL
PROCESSES
PROCESS 1 -REORGANIZE THE BIT IMAGE
PROCESS 2 - UNSCRAMBLE THE ENCODED DATA
PROCESS 3 - REED-SOLOMON DECODE DATA
TIME

FIG. 78

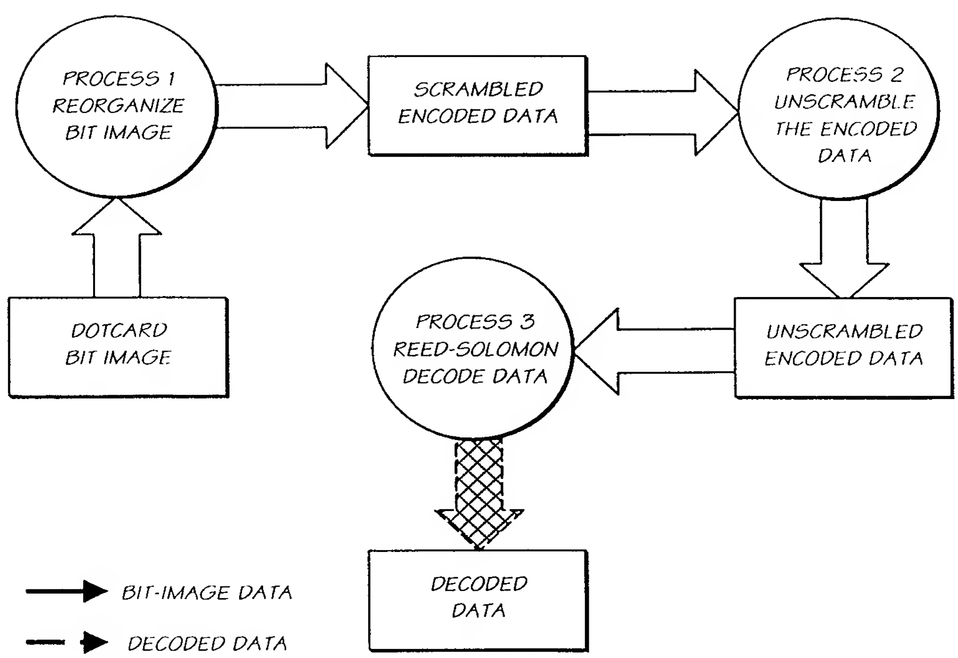

PROCESS 1 REORGANIZE BIT IMAGE
SCRAMBLED ENCODED DATA
PROCESS 2 UNSCRAMBLE THE ENCODED DATA
DOTCARD BIT IMAGE
PROCESS 3 REED-SOLOMON DECODE DATA
UNSCRAMBLED ENCODED DATA
DECODED DATA
BIT-IMAGE DATA
DECODED DATA

FIG. 79

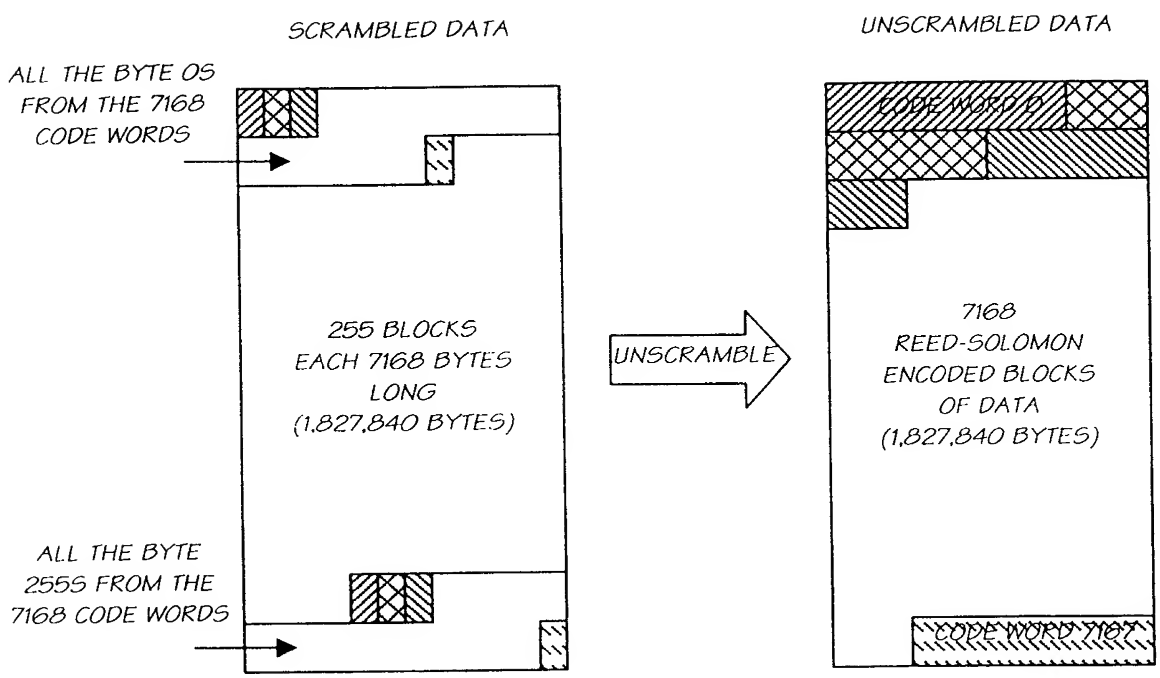

SCRAMBLED DATA
UNSCRAMBLED DATA
ALL THE BYTE 0S FROM THE 7168 CODE WORDS
255 BLOCKS EACH 7168 BYTES LONG (1,827,840 BYTES)
ALL THE BYTE 255S FROM THE 7168 CODE WORDS
UNSCRAMBLE
CODE WORD 0
7168 REED-SOLOMON ENCODED BLOCKS OF DATA (1,827,840 BYTES)
CODE WORD 7167

FIG. 80

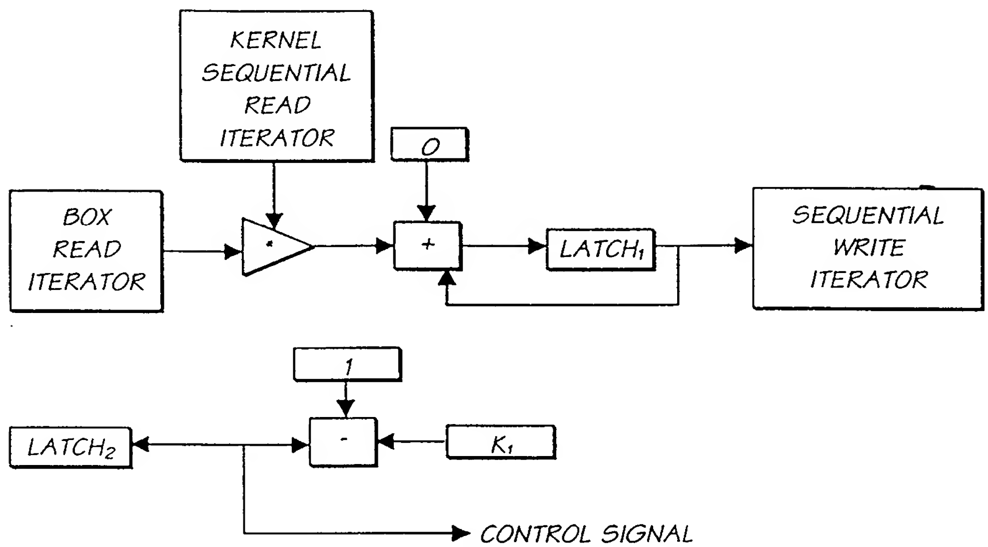

KERNEL SEQUENTIAL READ ITERATOR
0
BOX READ ITERATOR
*
+
LATCH1
SEQUENTIAL WRITE ITERATOR
1
LATCH2
-
K1
CONTROL SIGNAL

FIG. 81

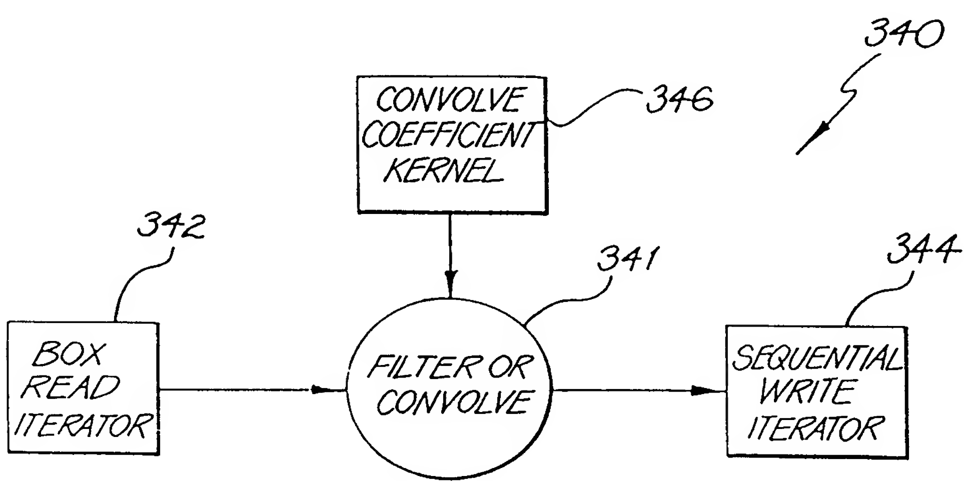

340
CONVOLVE COEFFICIENT KERNEL
346
342
341
344
BOX READ ITERATOR
FILTER OR CONVOLVE
SEQUENTIAL WRITE ITERATOR

FIG. 82

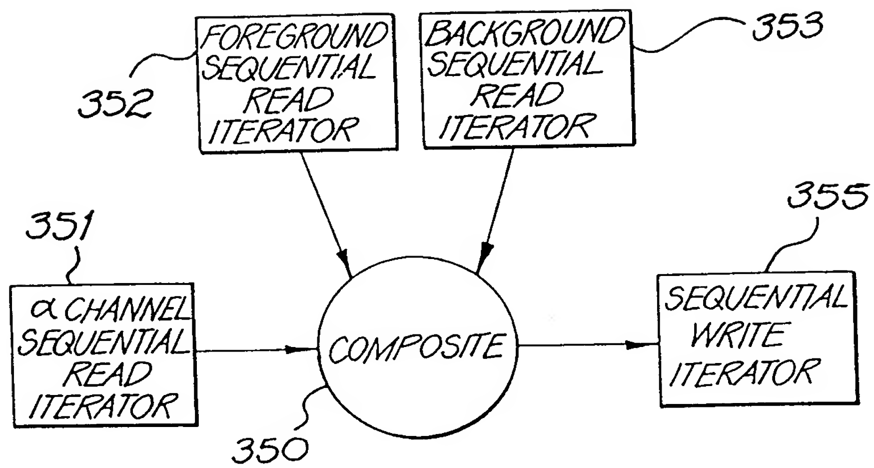
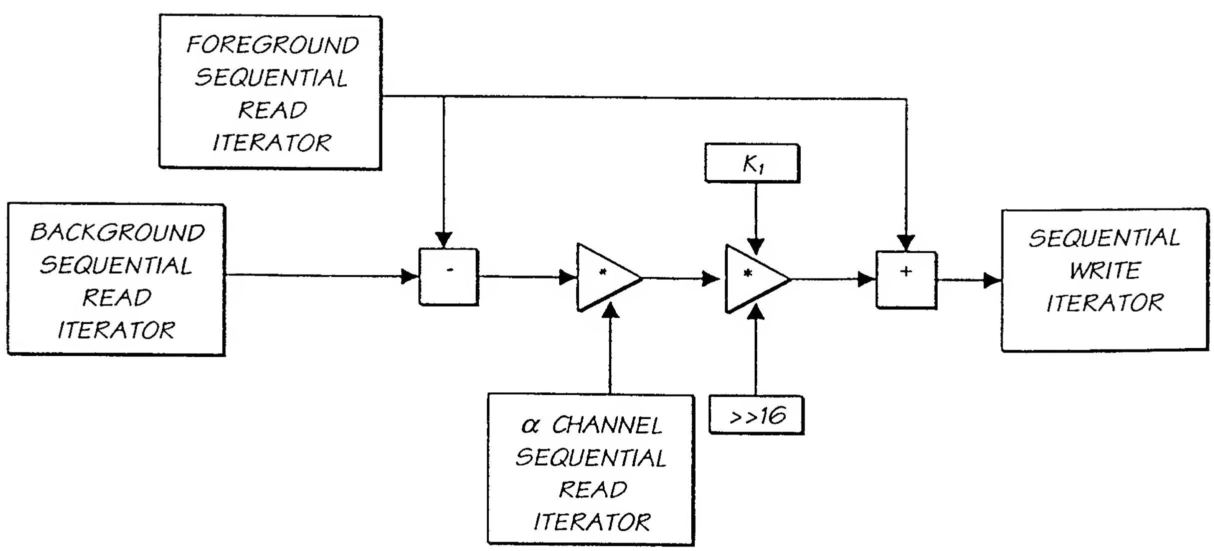

FOREGROUND SEQUENTIAL READ ITERATOR
BACKGROUND SEQUENTIAL READ ITERATOR
353
352
355
351
α CHANNEL SEQUENTIAL READ ITERATOR
COMPOSITE
SEQUENTIAL WRITE ITERATOR
350

FIG. 83


FOREGROUND SEQUENTIAL READ ITERATOR
K1
BACKGROUND SEQUENTIAL READ ITERATOR
-
*
*
+
SEQUENTIAL WRITE ITERATOR
α CHANNEL SEQUENTIAL READ ITERATOR
>>16

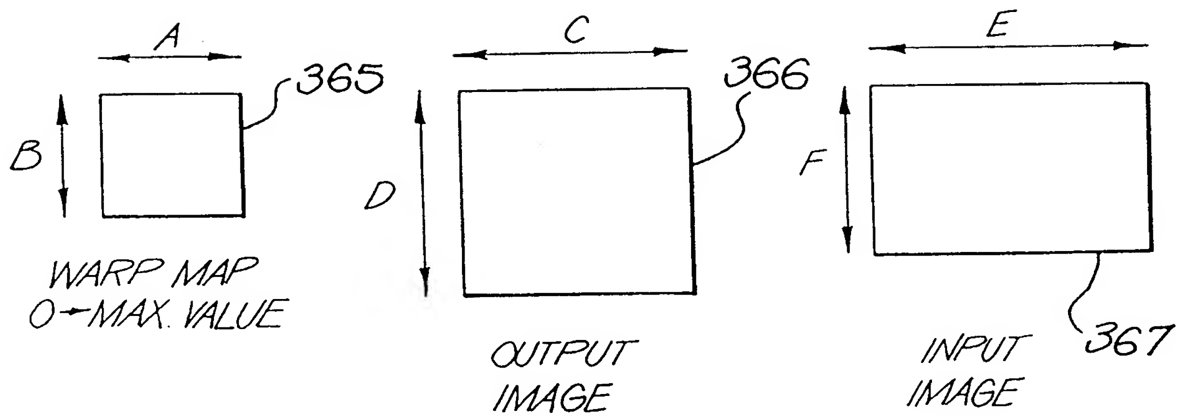

A
B
365
WARP MAP
0→MAX. VALUE
C
D
366
OUTPUT
IMAGE
E
F
367
INPUT
IMAGE

FIG. 85

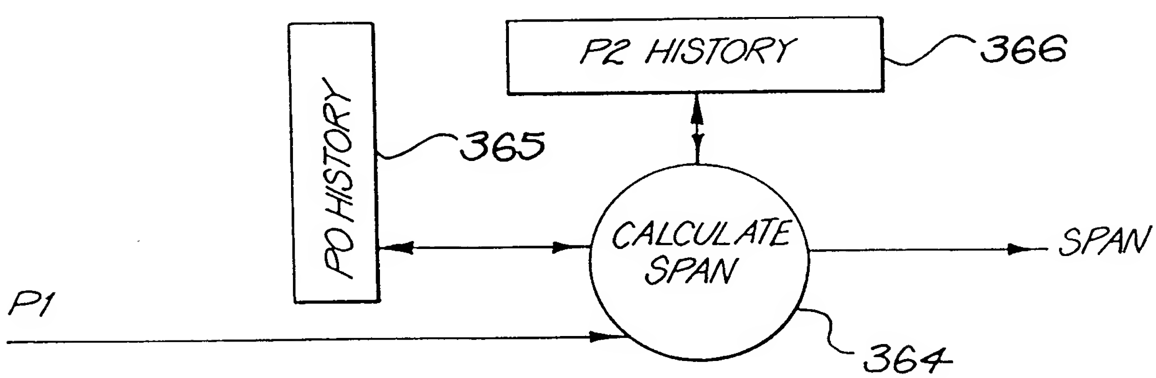
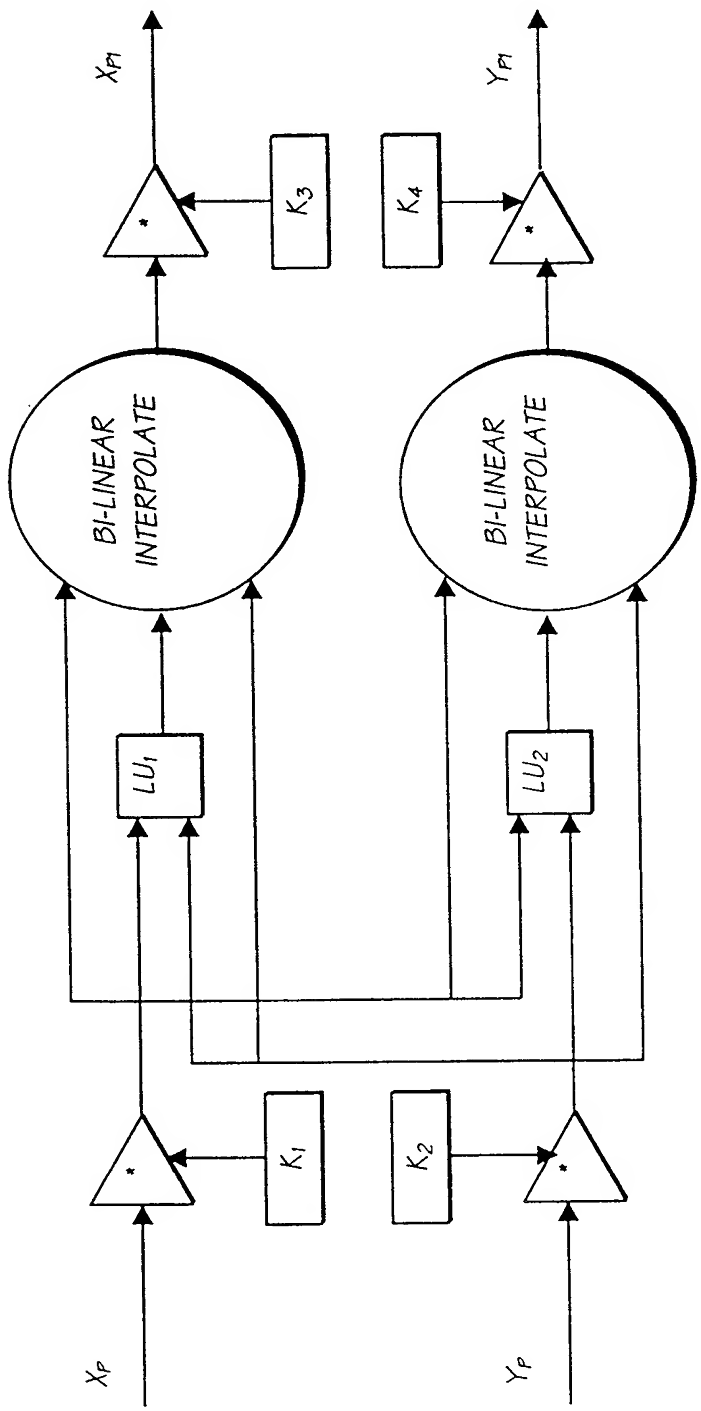

P0 HISTORY
365
P2 HISTORY
366
CALCULATE
SPAN
SPAN
P1
364

FIG. 86



X_P1
Y_P1
K3
K4
BI-LINEAR INTERPOLATE
BI-LINEAR INTERPOLATE
LU1
LU2
K1
K2
X_P
Y_P

FIG. 87

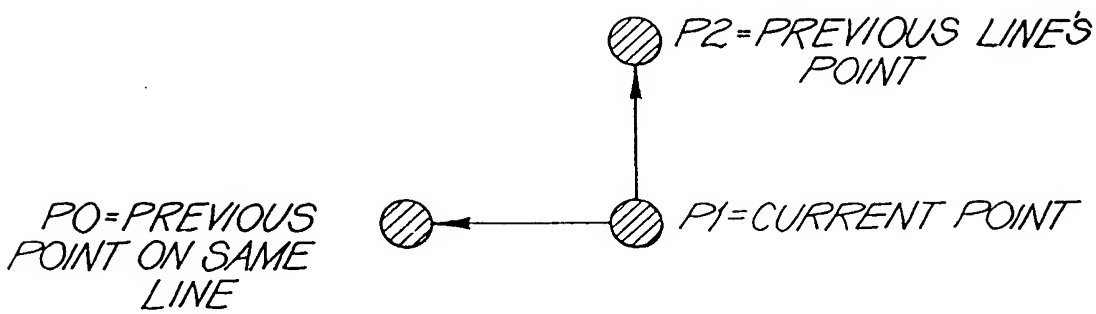

P2=PREVIOUS LINE'S POINT
P0=PREVIOUS POINT ON SAME LINE
P1=CURRENT POINT

FIG. 88

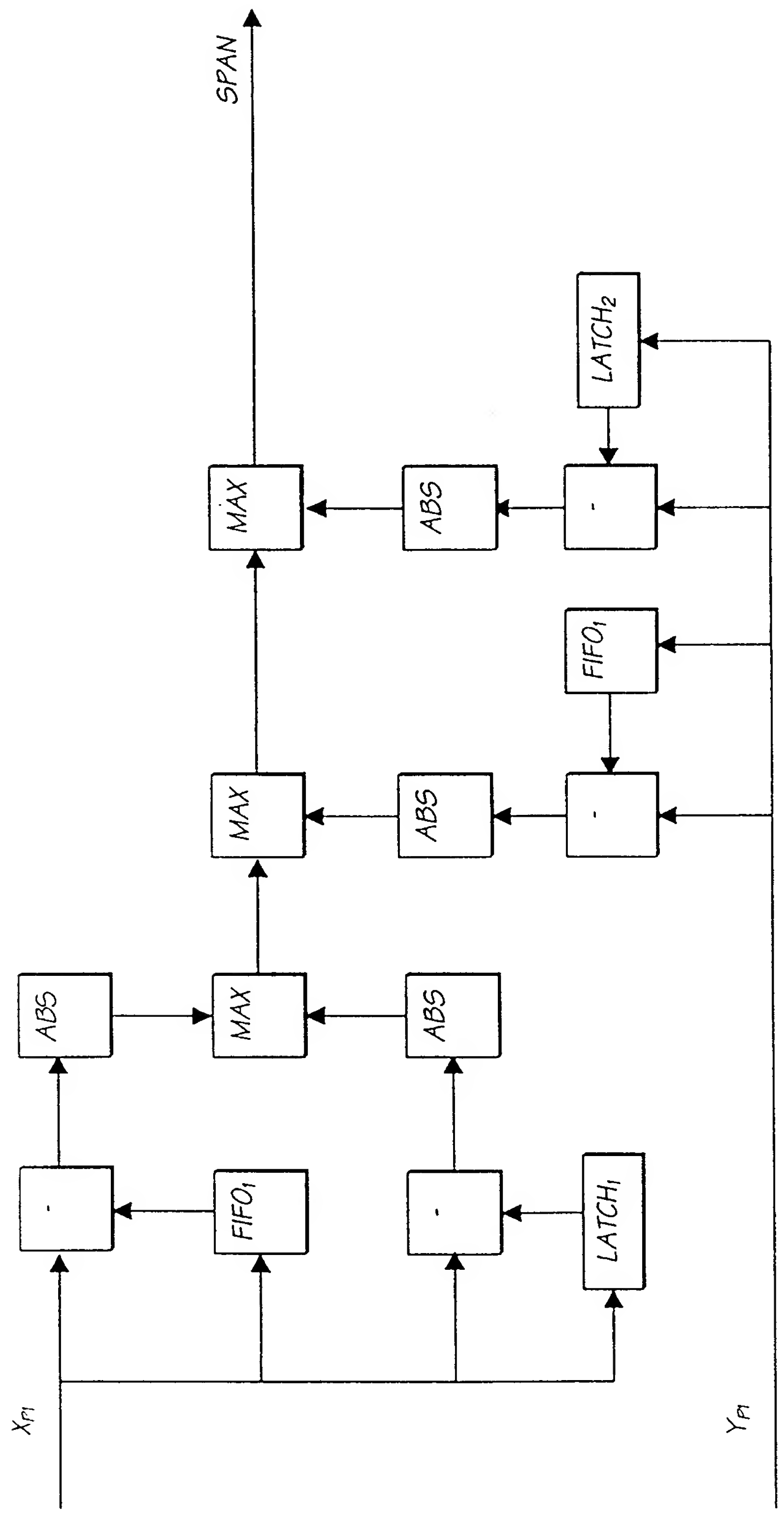

SPAN
MAX
MAX
MAX
ABS
ABS
ABS
ABS
-
-
-
-
FIFO1
FIFO1
LATCH1
LATCH2
XP1
YP1

FIG. 89

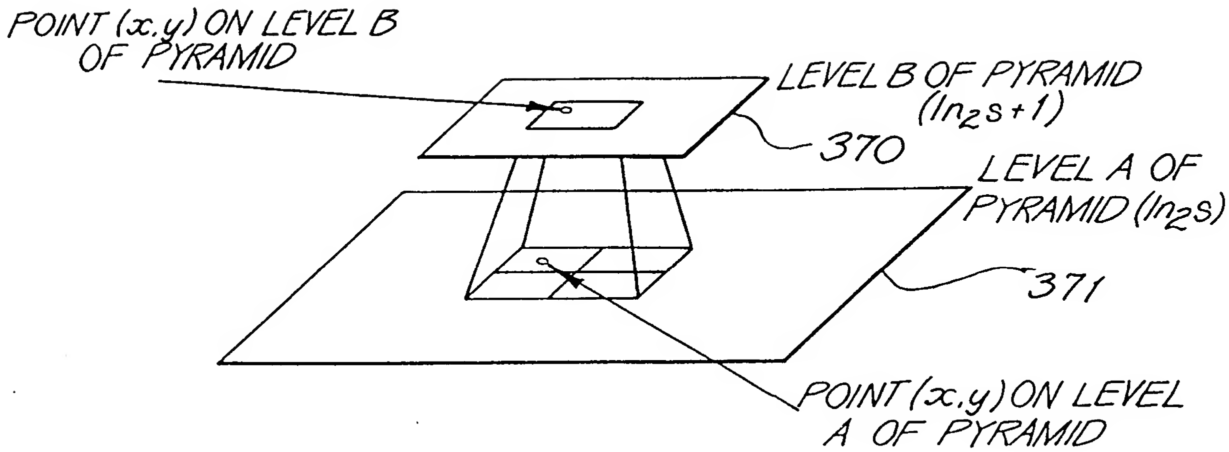

POINT (x,y) ON LEVEL B OF PYRAMID
LEVEL B OF PYRAMID ($ln_2 s+1$)
370
LEVEL A OF PYRAMID ($ln_2 s$)
371
POINT (x,y) ON LEVEL A OF PYRAMID

FIG. 90

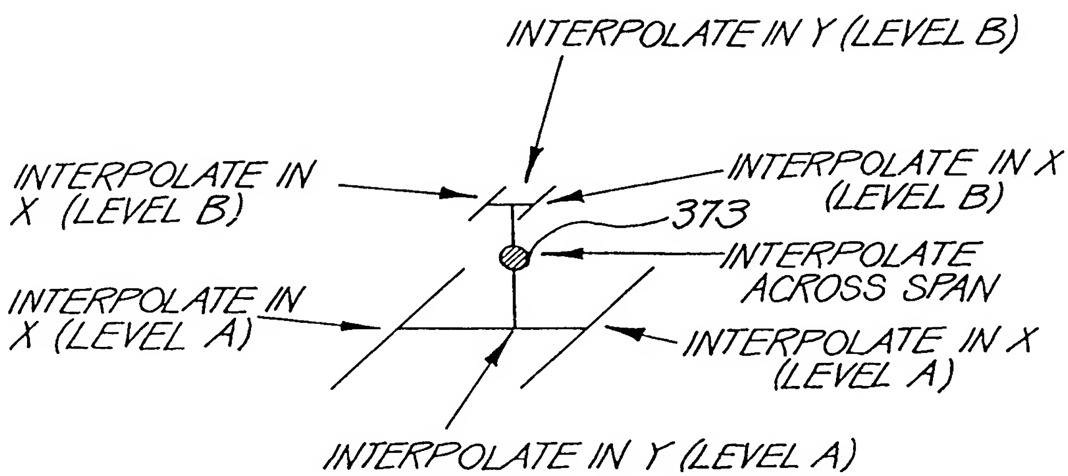

INTERPOLATE IN Y (LEVEL B)
INTERPOLATE IN X (LEVEL B)
INTERPOLATE IN X (LEVEL B)
373
INTERPOLATE ACROSS SPAN
INTERPOLATE IN X (LEVEL A)
INTERPOLATE IN X (LEVEL A)
INTERPOLATE IN Y (LEVEL A)

FIG. 91

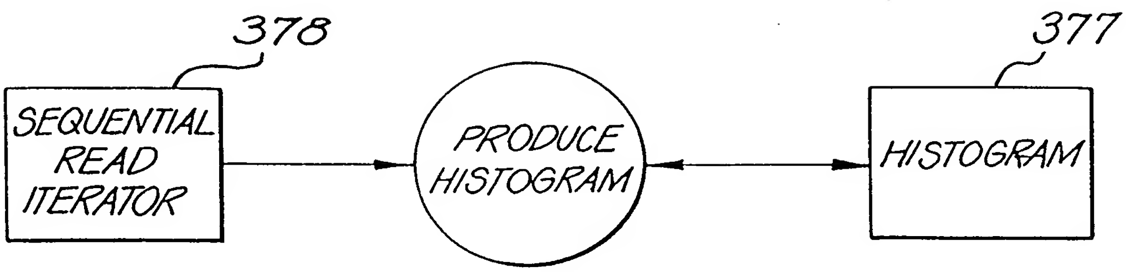

378
SEQUENTIAL READ ITERATOR
PRODUCE HISTOGRAM
377
HISTOGRAM

FIG. 92

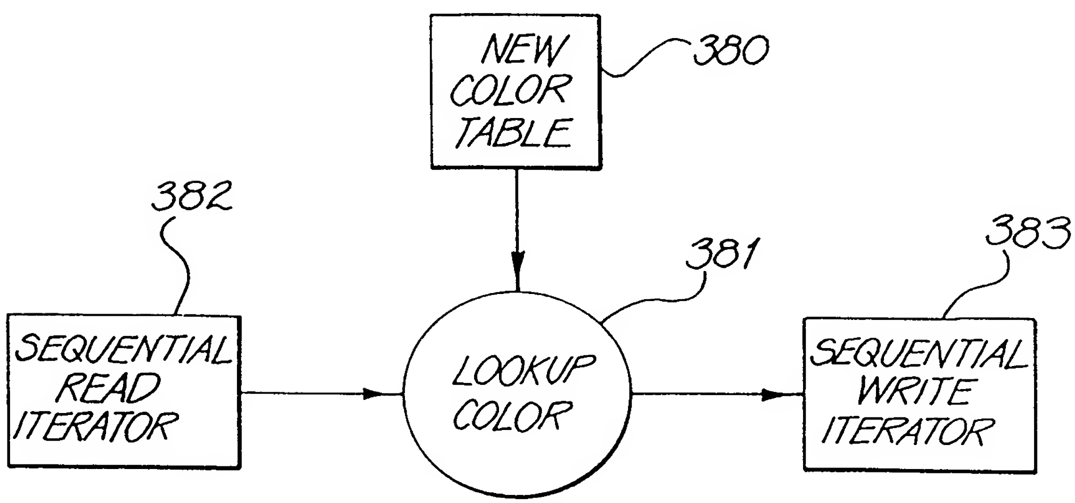

NEW COLOR TABLE
380
382
381
383
SEQUENTIAL READ ITERATOR
LOOKUP COLOR
SEQUENTIAL WRITE ITERATOR

FIG. 93

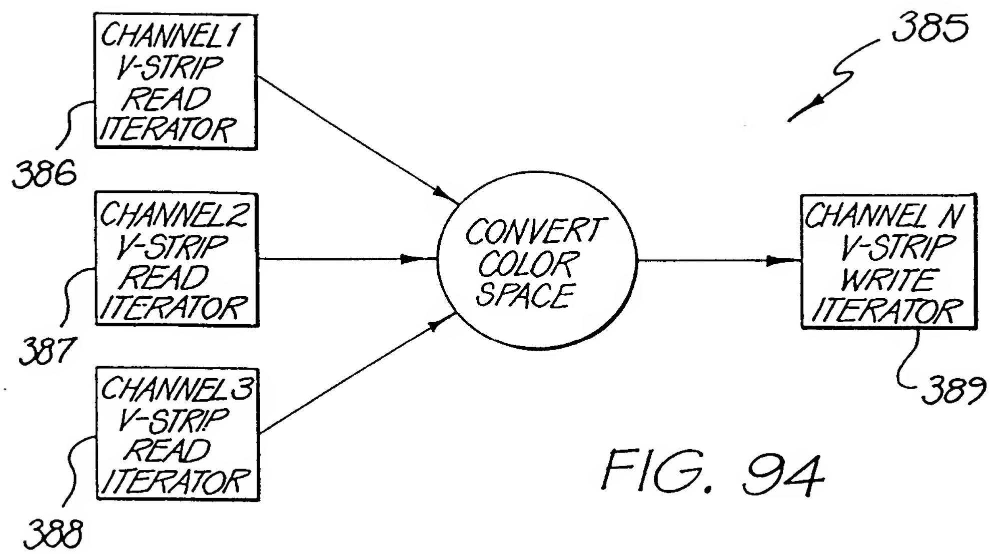


FIG. 94

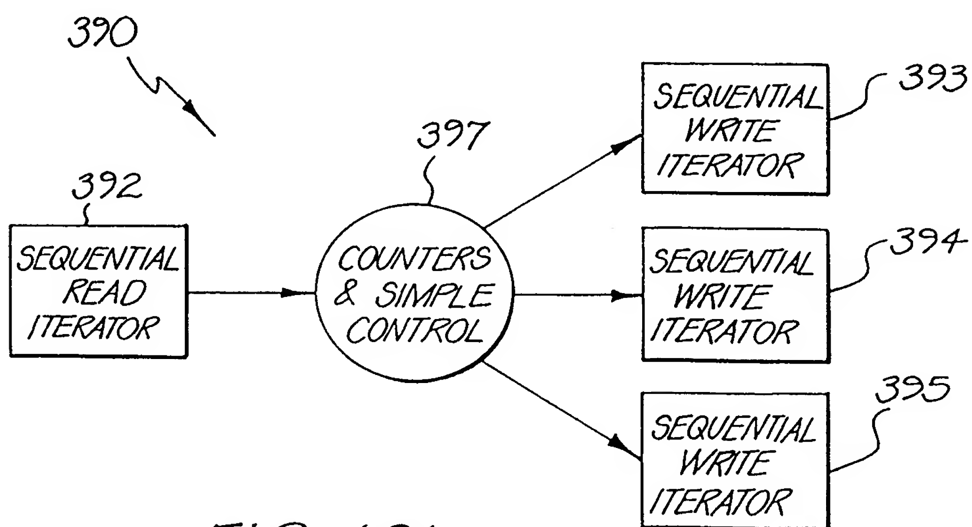
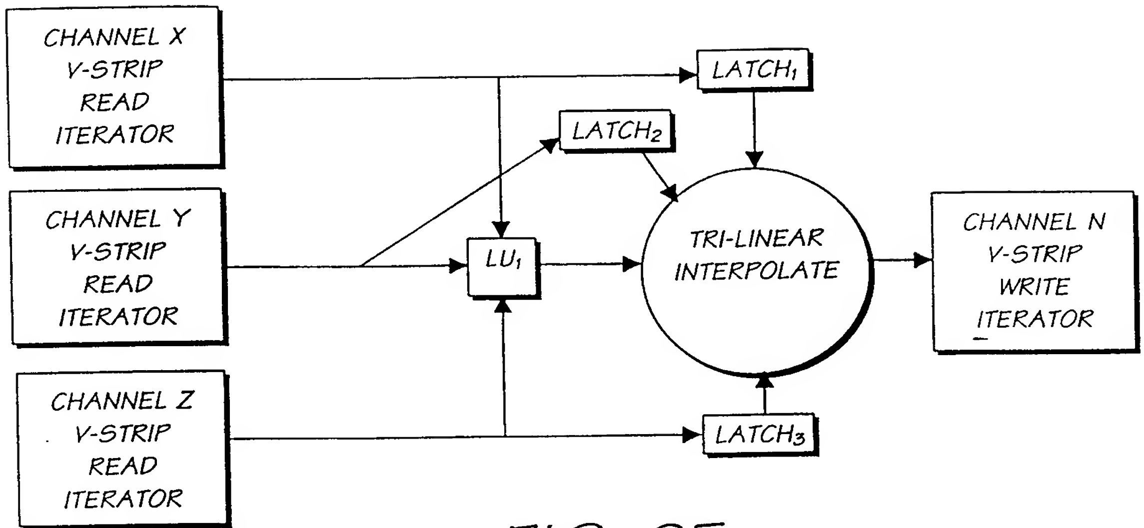
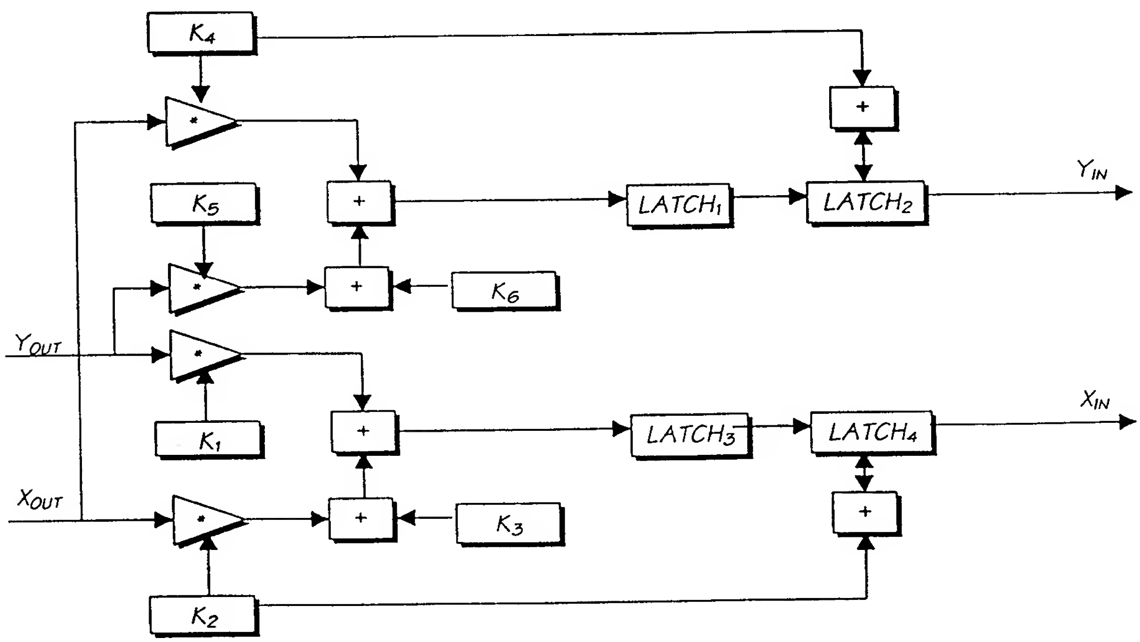


FIG. 101



CHANNEL X V-STRIP READ ITERATOR
CHANNEL Y V-STRIP READ ITERATOR
CHANNEL Z V-STRIP READ ITERATOR
LATCH₁
LATCH₂
LATCH₃
LU₁
TRI-LINEAR INTERPOLATE
CHANNEL N V-STRIP WRITE ITERATOR

FIG. 95



K₄
K₅
K₆
K₁
K₃
K₂
+
LATCH₁
LATCH₂
LATCH₃
LATCH₄
Y_IN
X_IN
Y_OUT
X_OUT

FIG. 96

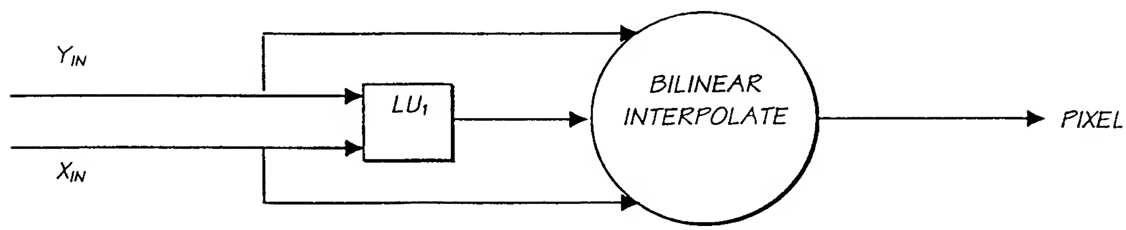

Y_{IN}
X_{IN}
LU_1
BILINEAR INTERPOLATE
PIXEL

FIG. 97

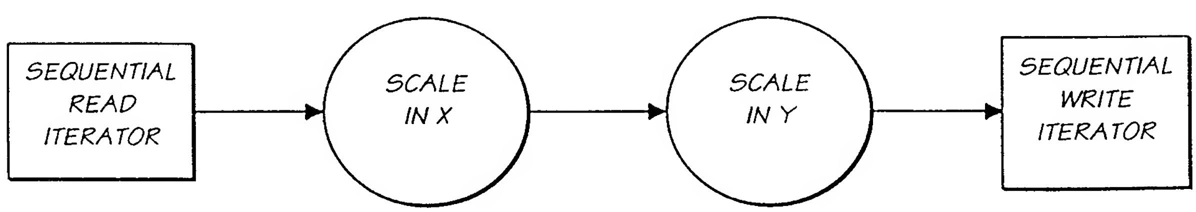

SEQUENTIAL READ ITERATOR
SCALE IN X
SCALE IN Y
SEQUENTIAL WRITE ITERATOR

FIG. 98

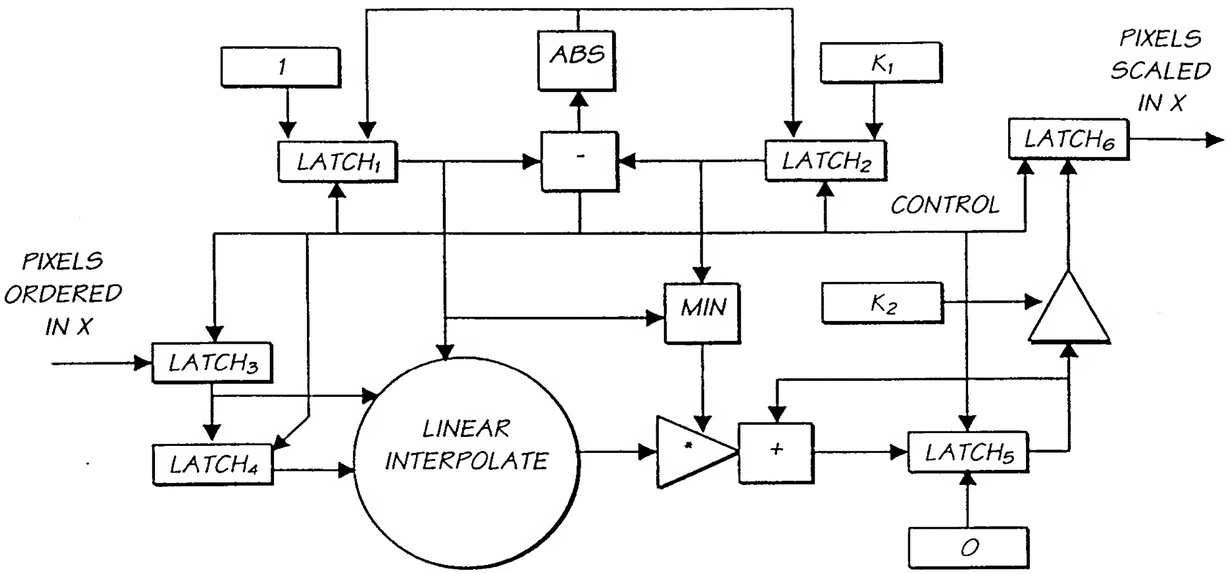


FIG. 99

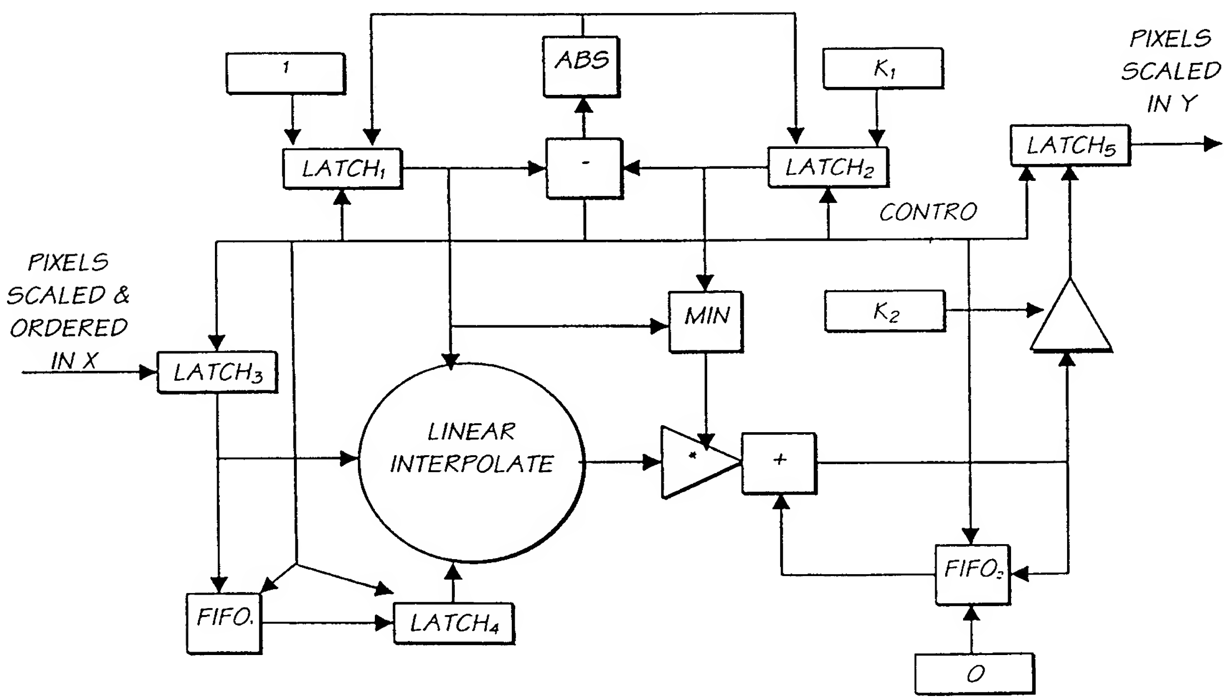


FIG. 100

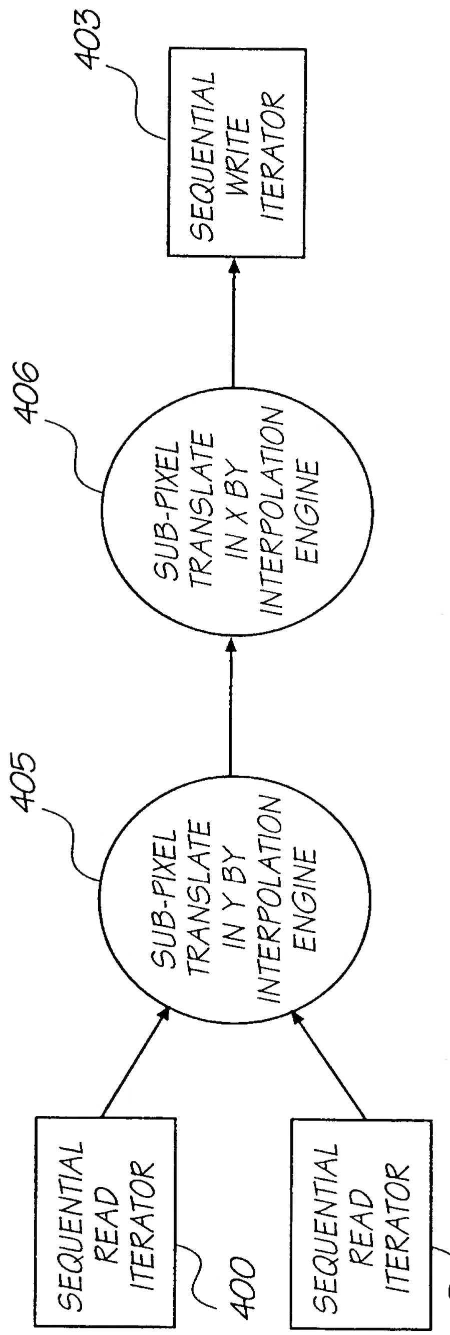


FIG. 102

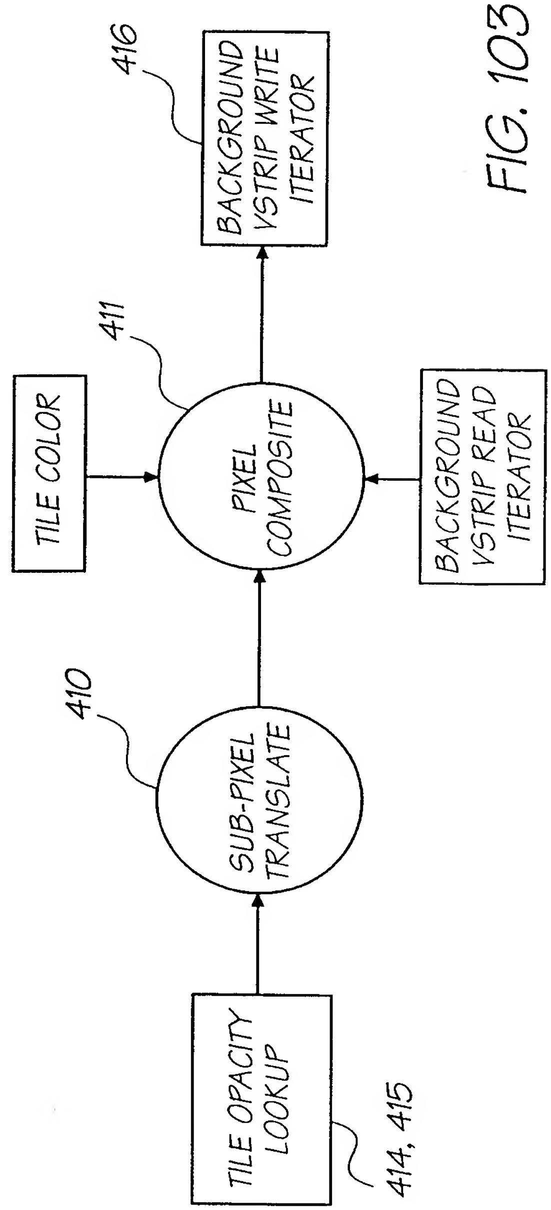


FIG. 103

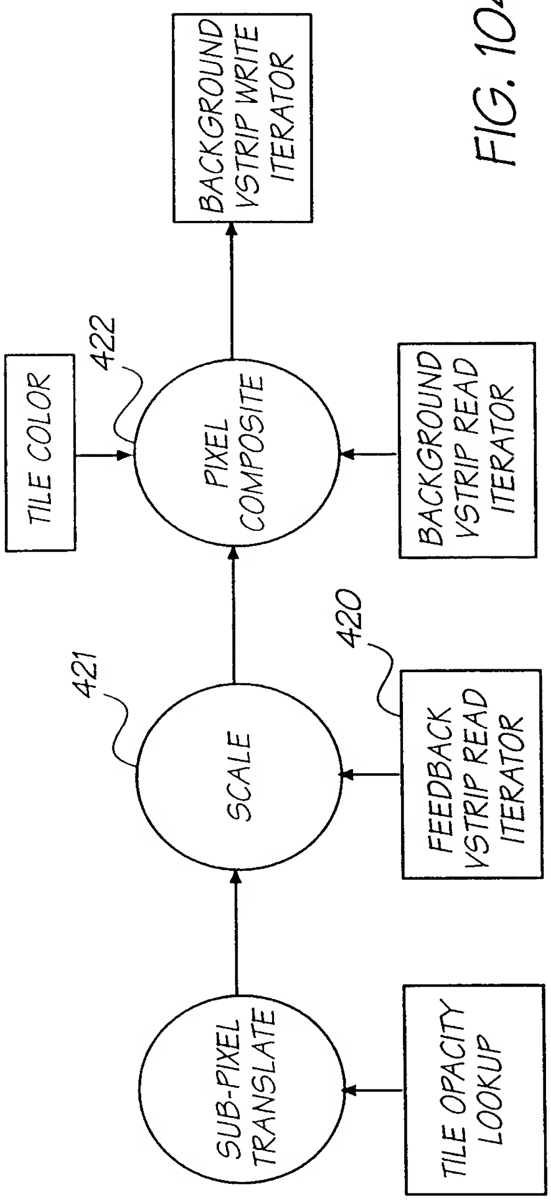


FIG. 104

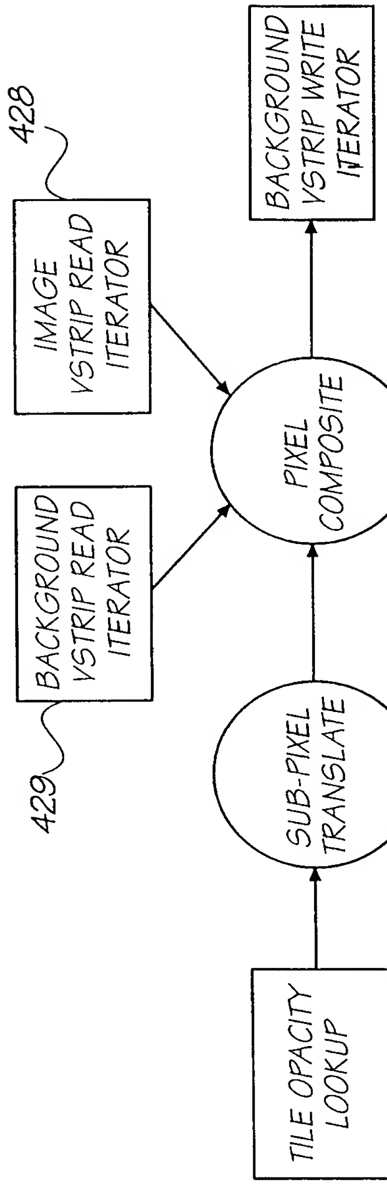


FIG. 105

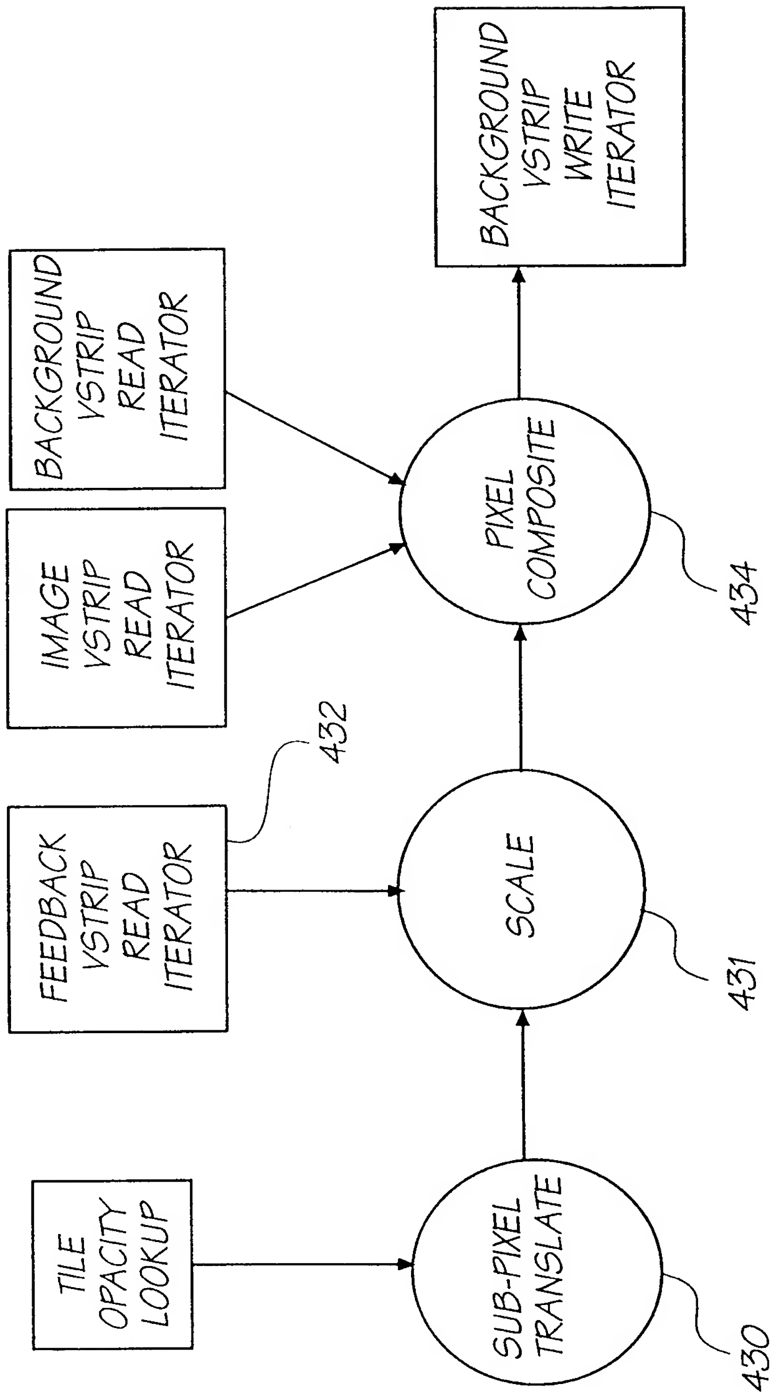

TILE OPACITY LOOKUP
SUB-PIXEL TRANSLATE
430
FEEDBACK VSTRIP READ ITERATOR
432
SCALE
431
IMAGE VSTRIP READ ITERATOR
BACKGROUND VSTRIP READ ITERATOR
PIXEL COMPOSITE
434
BACKGROUND VSTRIP WRITE ITERATOR

FIG. 106

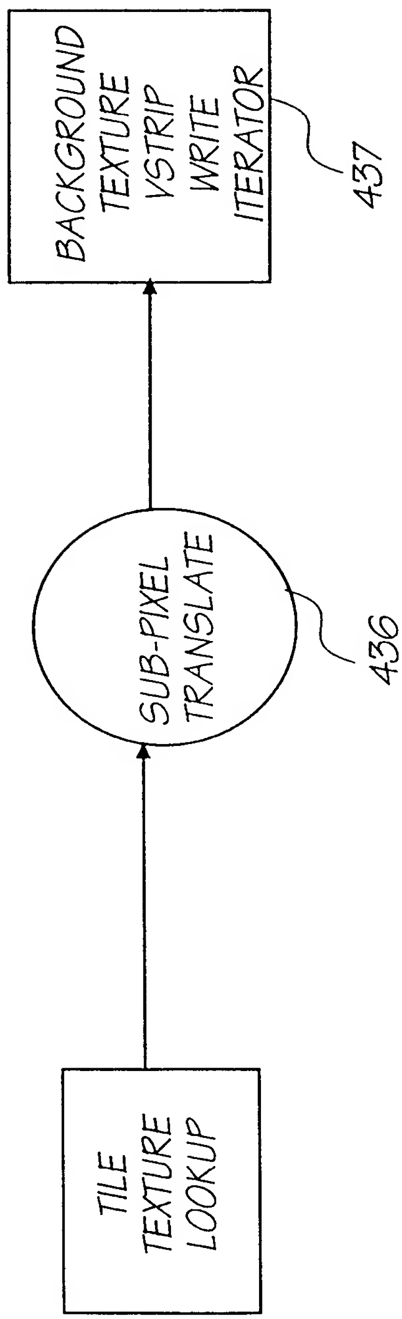

BACKGROUND TEXTURE VSTRIP WRITE ITERATOR
437
SUB-PIXEL TRANSLATE
436
TILE TEXTURE LOOKUP

FIG. 107

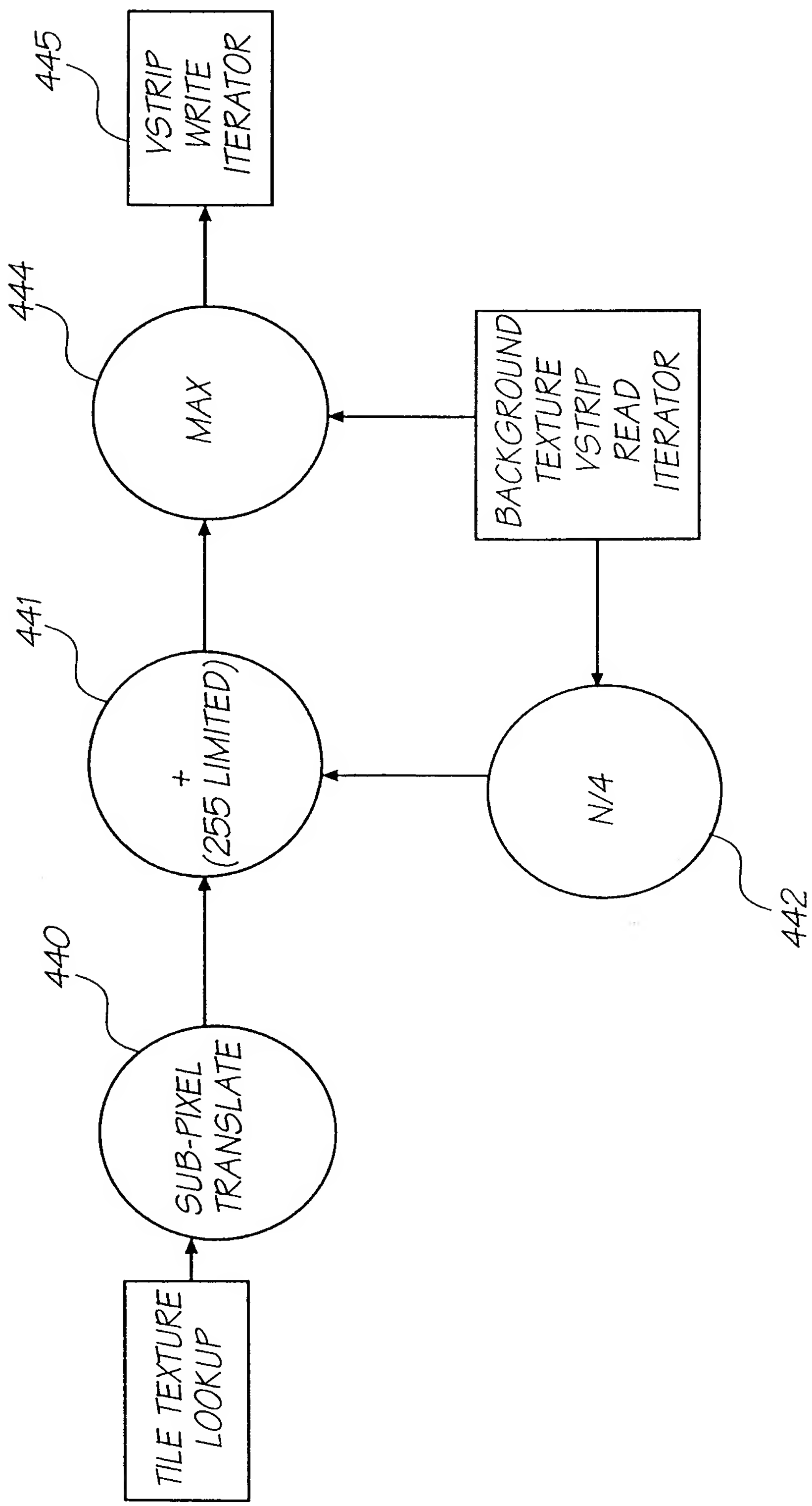

VSTRIP WRITE ITERATOR
445
MAX
444
BACKGROUND TEXTURE VSTRIP READ ITERATOR
+ (255 LIMITED)
441
N/4
442
SUB-PIXEL TRANSLATE
440
TILE TEXTURE LOOKUP

FIG. 108

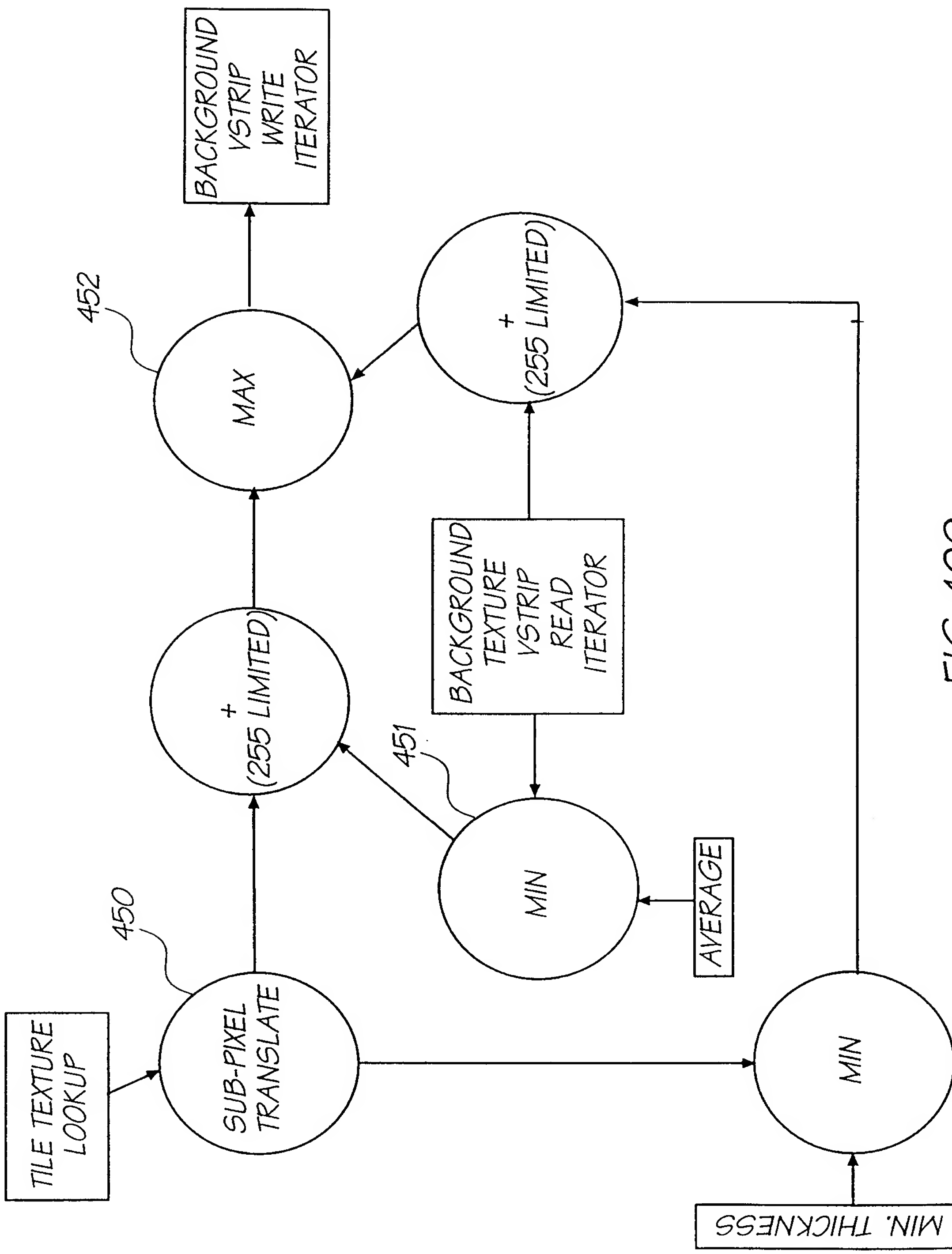

BACKGROUND VSTRIP WRITE ITERATOR
452
MAX
+ (255 LIMITED)
BACKGROUND TEXTURE VSTRIP READ ITERATOR
+ (255 LIMITED)
451
MIN
AVERAGE
450
TILE TEXTURE LOOKUP
SUB-PIXEL TRANSLATE
MIN
MIN. THICKNESS

FIG. 109

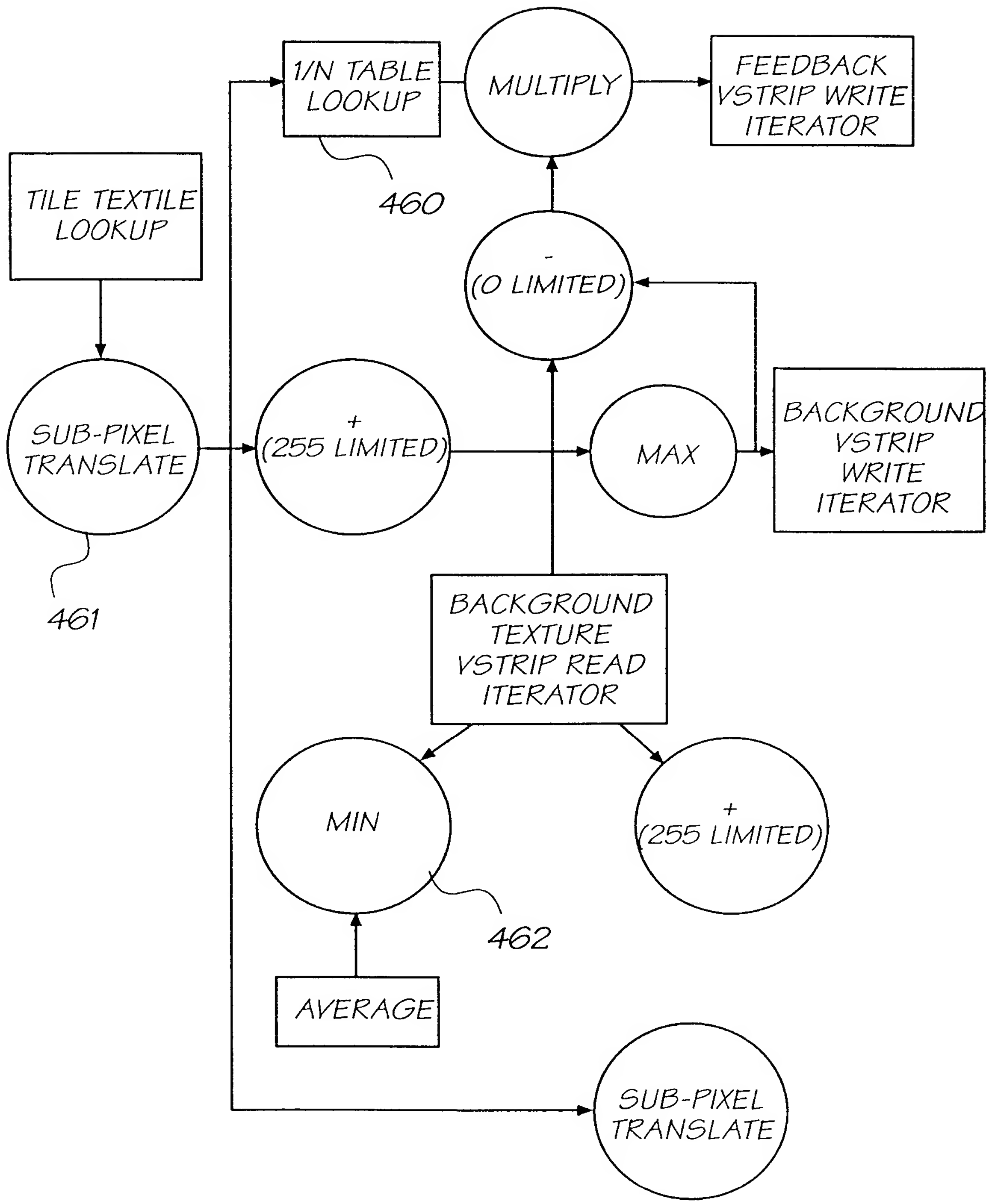

1/N TABLE LOOKUP
MULTIPLY
FEEDBACK VSTRIP WRITE ITERATOR
TILE TEXTILE LOOKUP
460
-
(0 LIMITED)
SUB-PIXEL TRANSLATE
+
(255 LIMITED)
MAX
BACKGROUND VSTRIP WRITE ITERATOR
461
BACKGROUND TEXTURE VSTRIP READ ITERATOR
MIN
+
(255 LIMITED)
462
AVERAGE
SUB-PIXEL TRANSLATE

FIG. 110

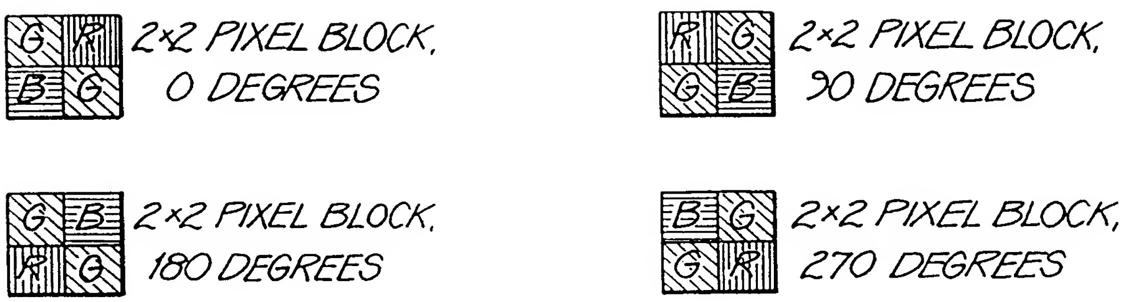


FIG. 111

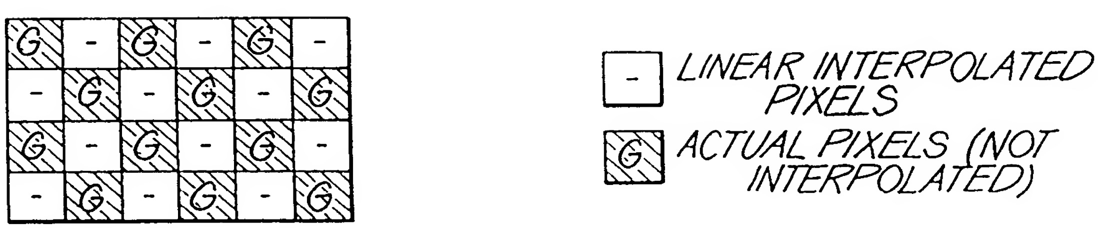


FIG. 112

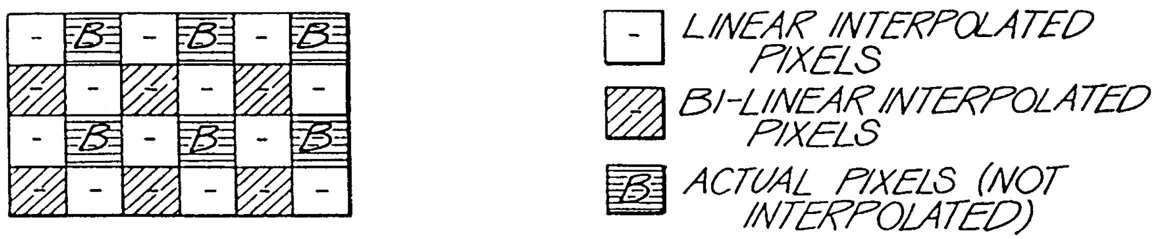


FIG. 113

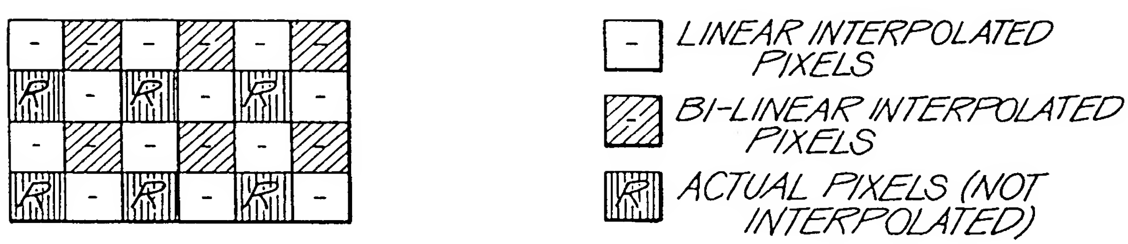


FIG. 114

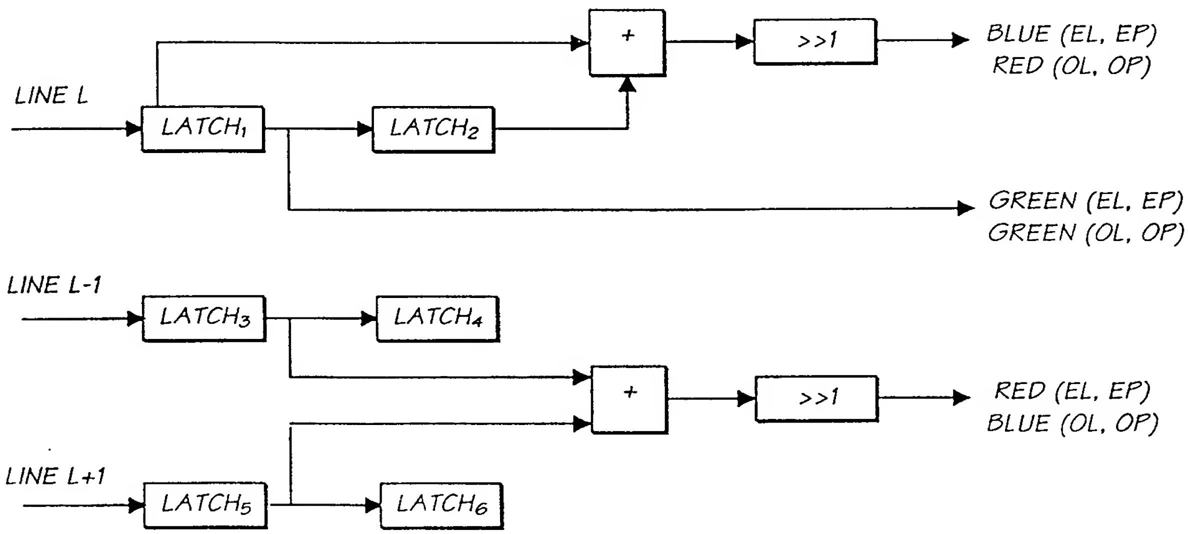


FIG. 115

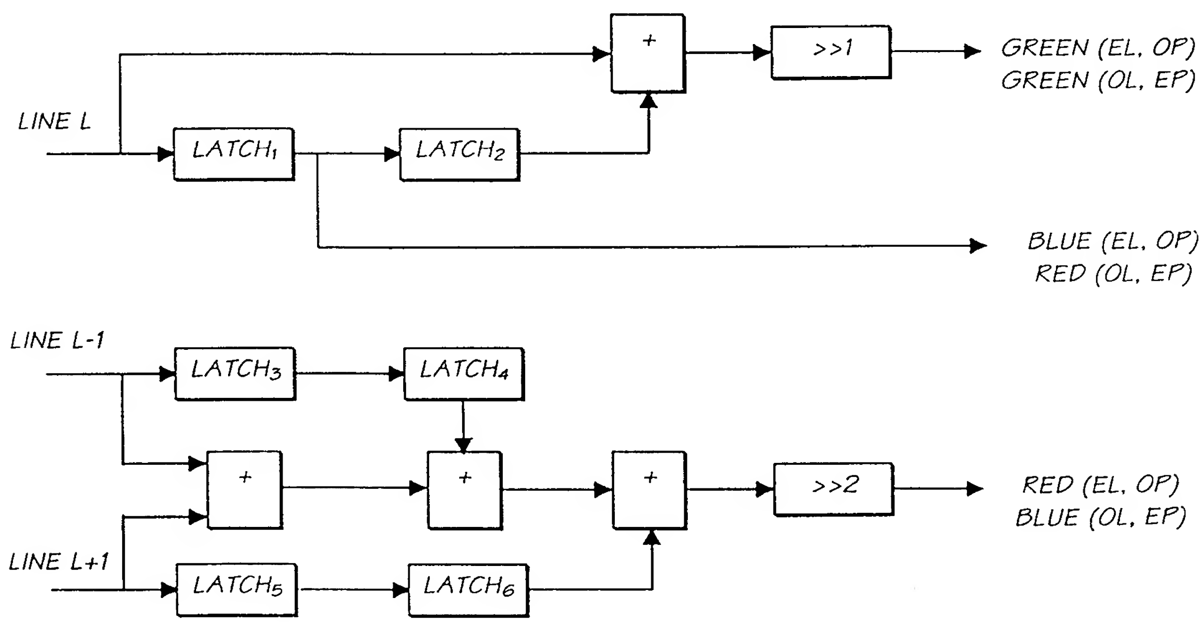


FIG. 116

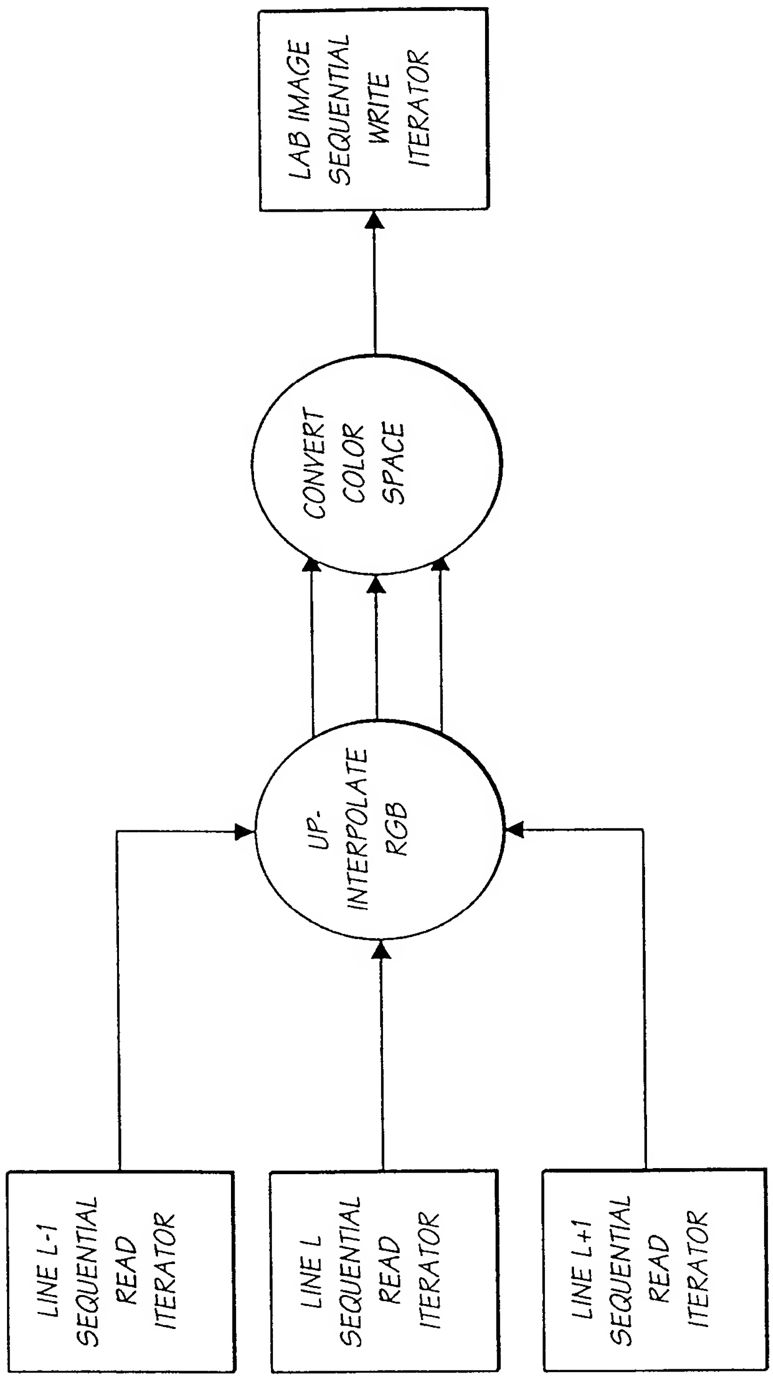

LAB IMAGE SEQUENTIAL WRITE ITERATOR
CONVERT COLOR SPACE
UP-INTERPOLATE RGB
LINE L-1 SEQUENTIAL READ ITERATOR
LINE L SEQUENTIAL READ ITERATOR
LINE L+1 SEQUENTIAL READ ITERATOR

FIG. 117

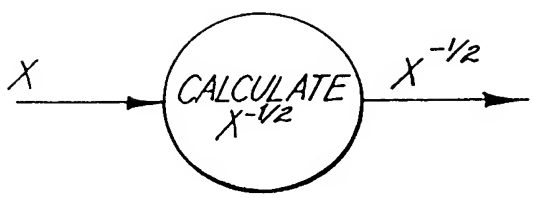


FIG. 118

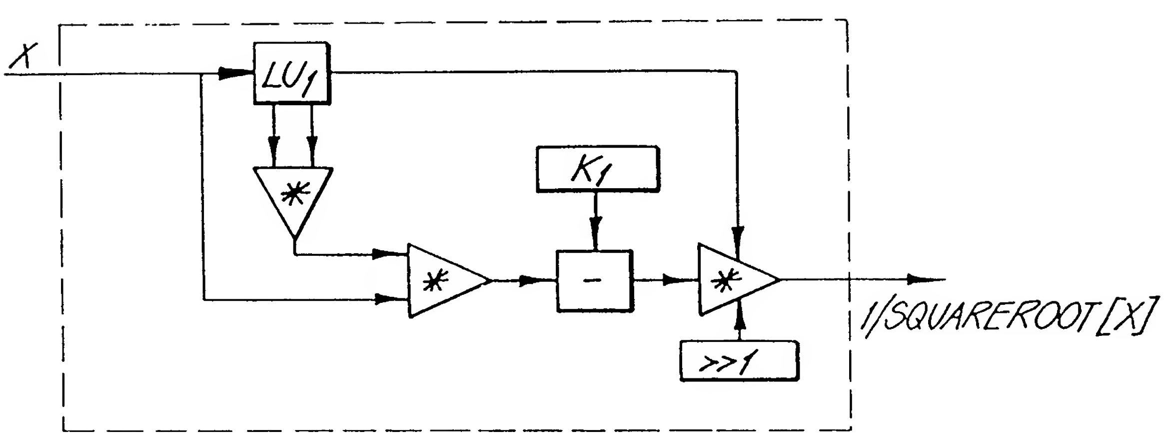


FIG. 119

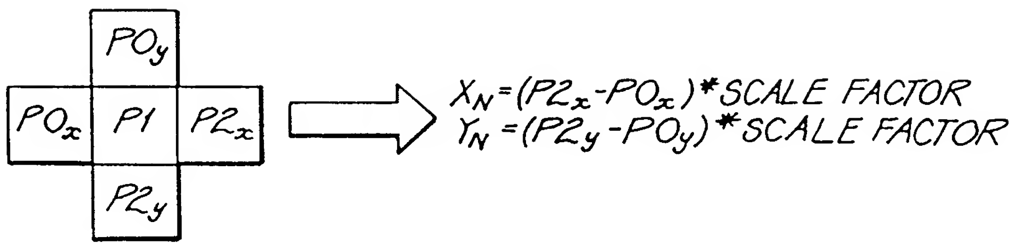


FIG. 120

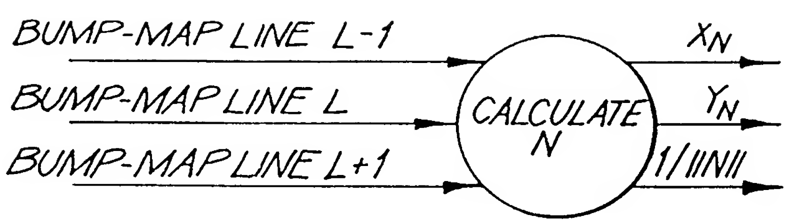


FIG. 121

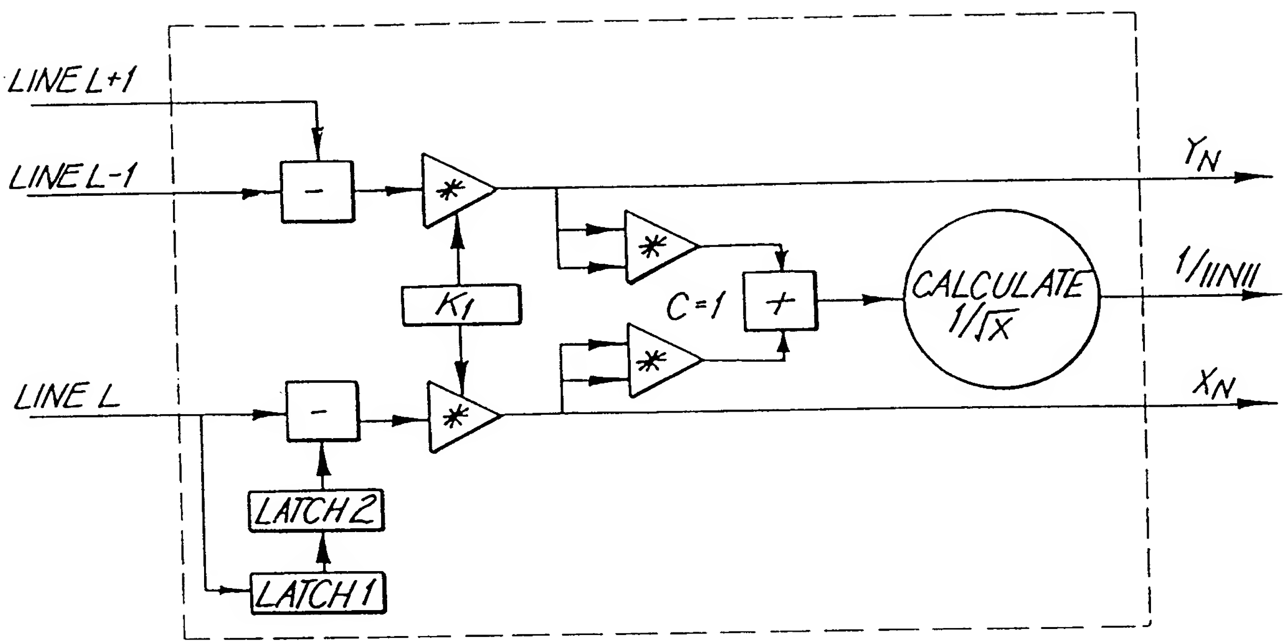

LINE L+1
LINE L-1
LINE L
–
–
*
*
*
*
K_1
C=1
+
CALCULATE
$1/\sqrt{X}$
LATCH 2
LATCH 1
Y_N
$1/\|N\|$
X_N

FIG. 122

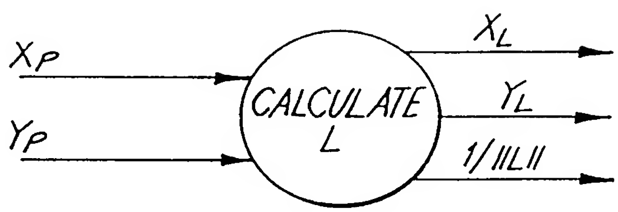


FIG. 123

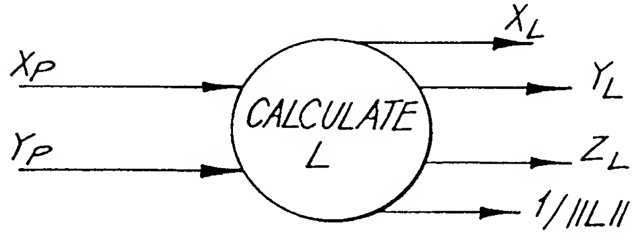


FIG. 124

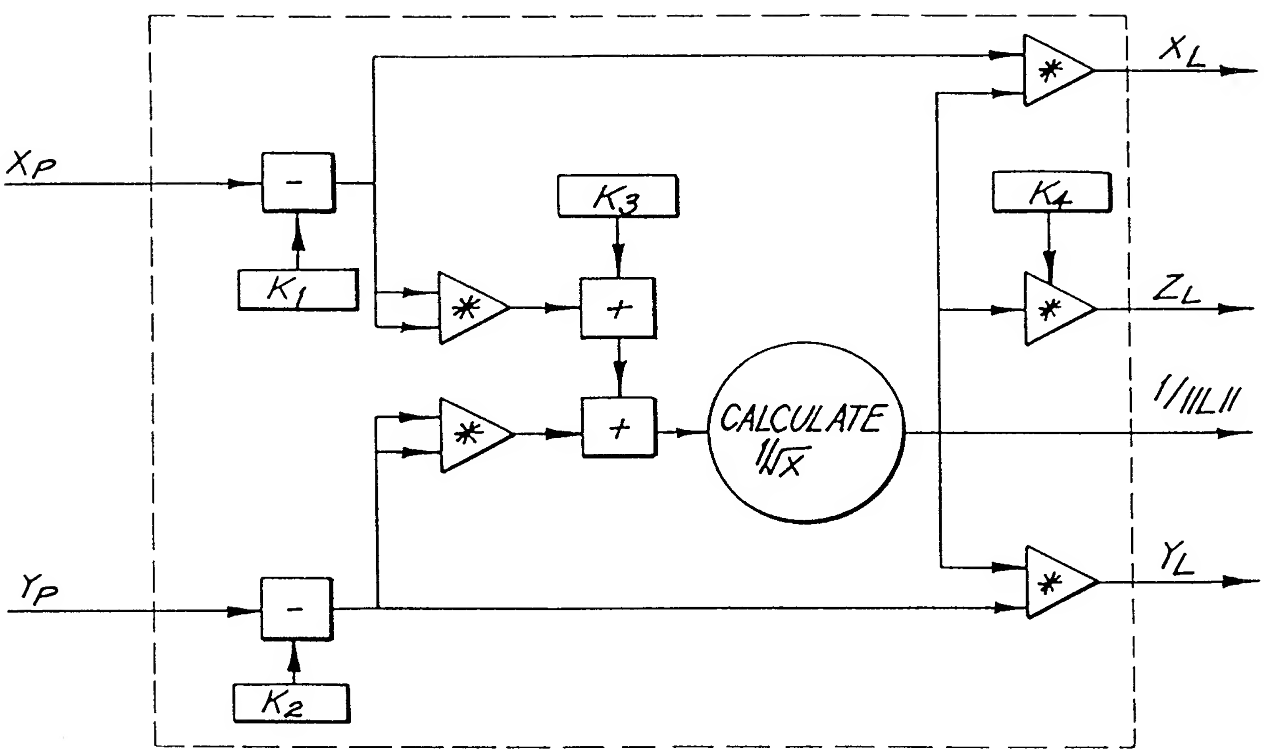


FIG. 125

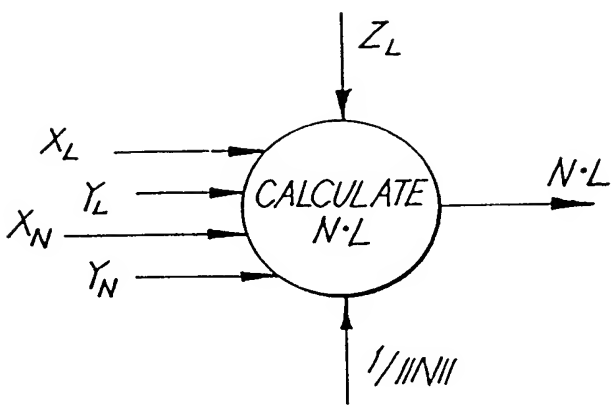


FIG. 126

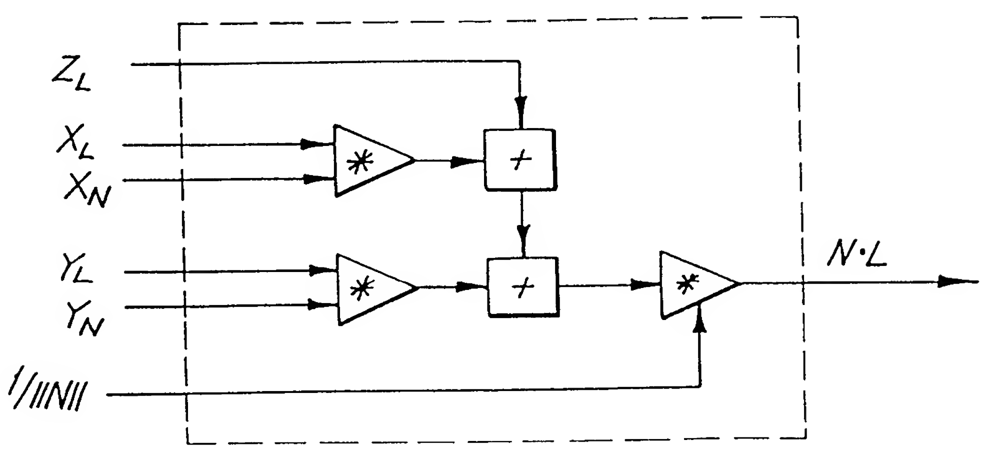


FIG. 127

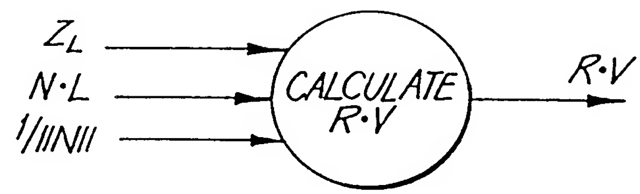


FIG. 128

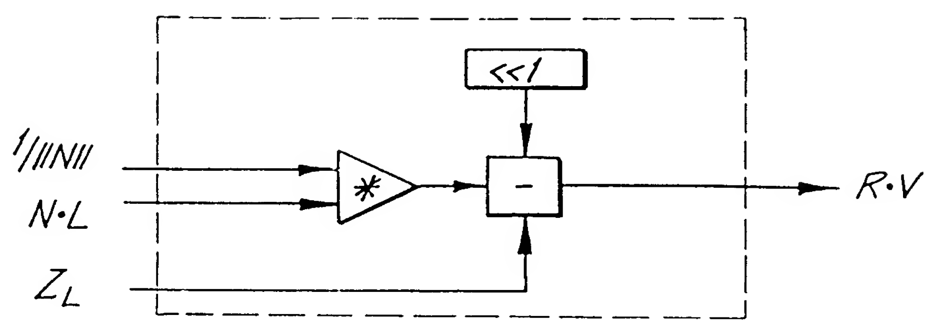


FIG. 129

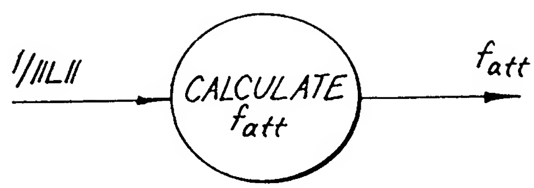


FIG. 130

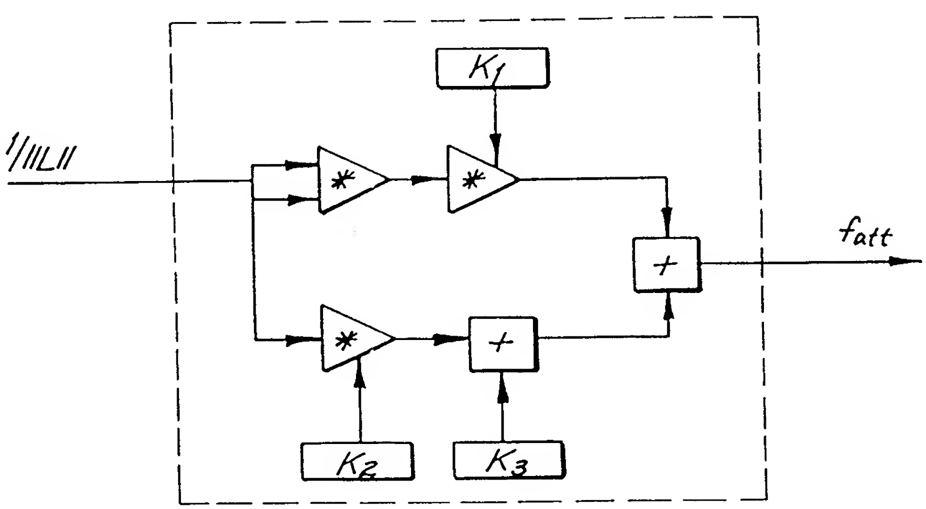


FIG. 131

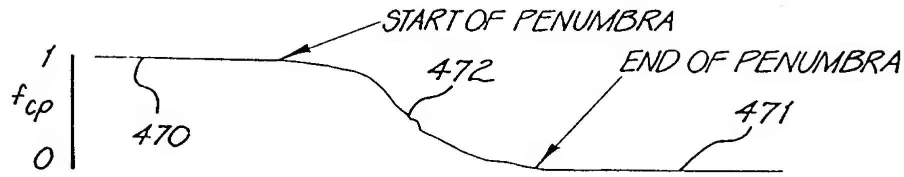


FIG. 132

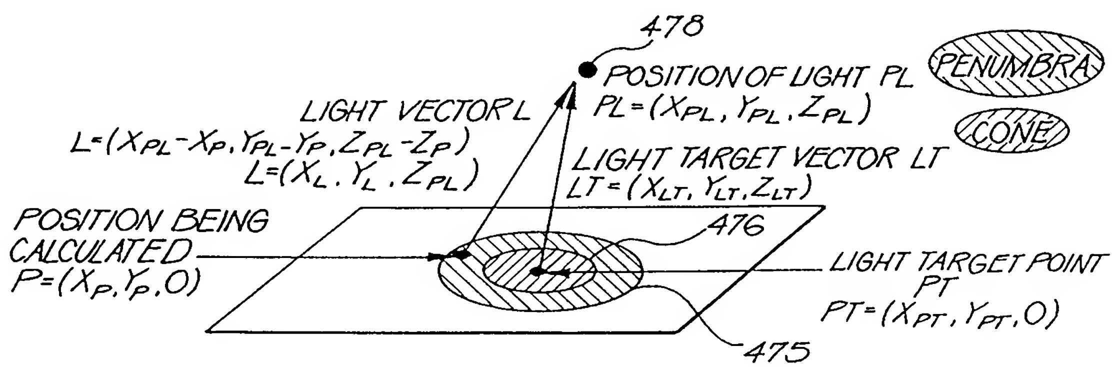


FIG. 133

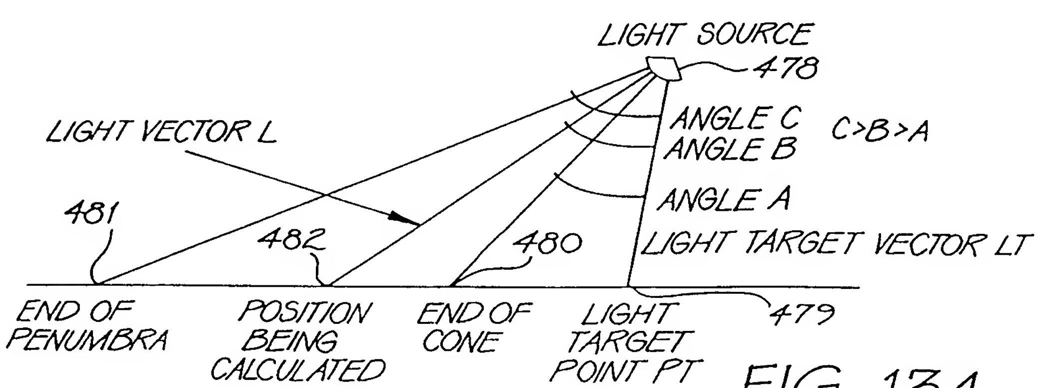


FIG. 134

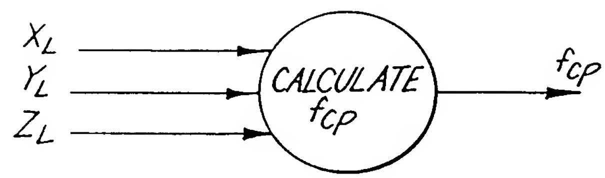


FIG. 135

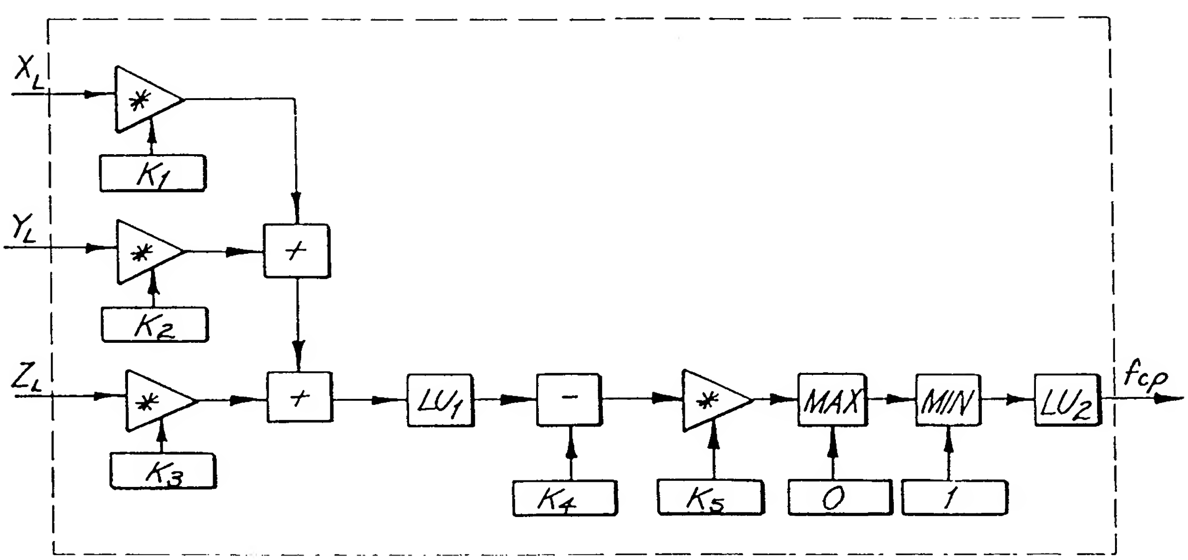


FIG. 136

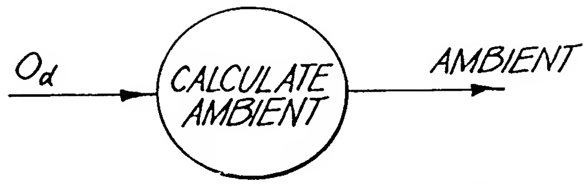


FIG. 137

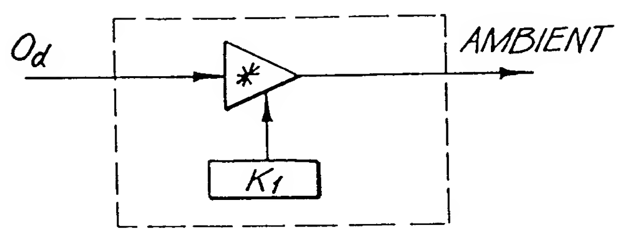


FIG. 138

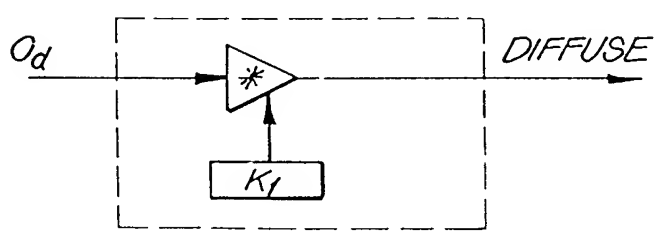


FIG. 139

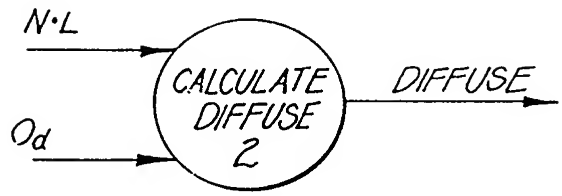


FIG. 140

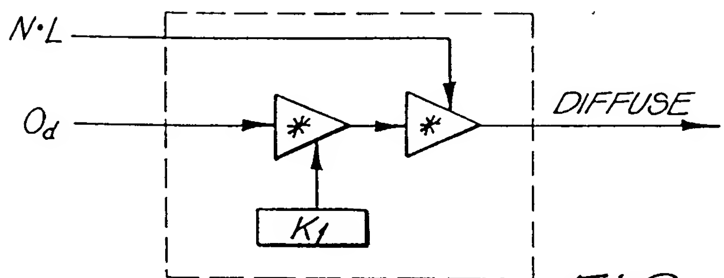


FIG. 141

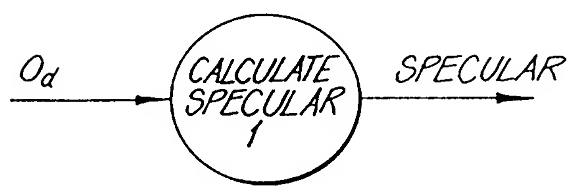


FIG. 142

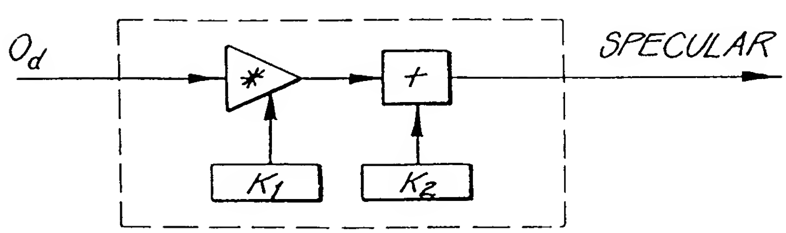


FIG. 143

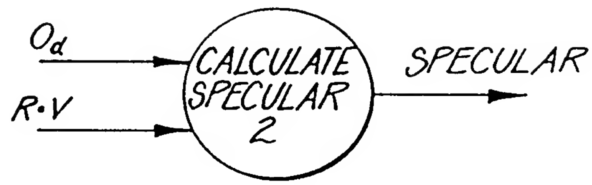


FIG. 144

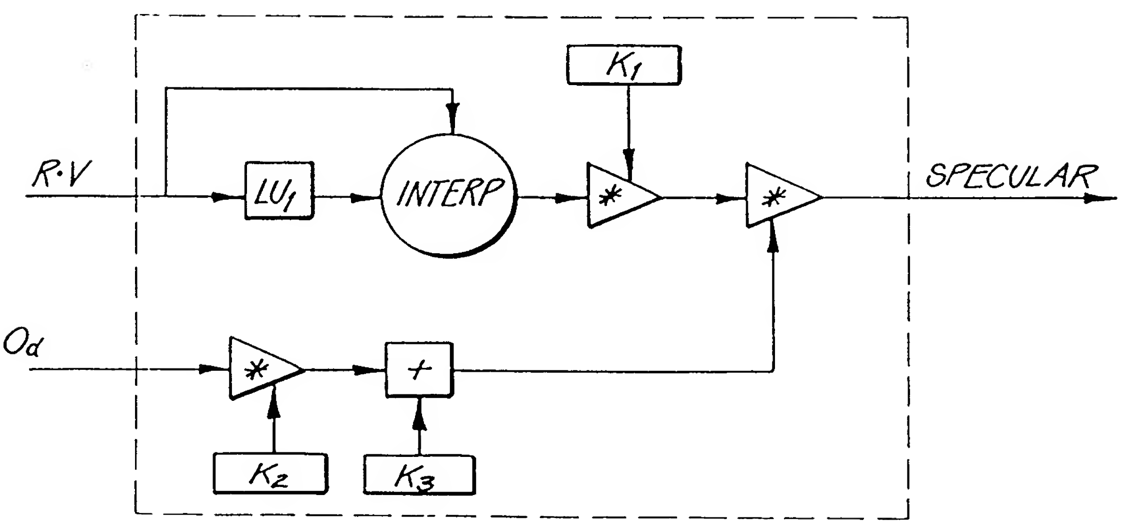


FIG. 145

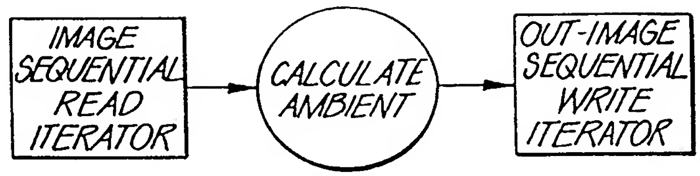


FIG. 146

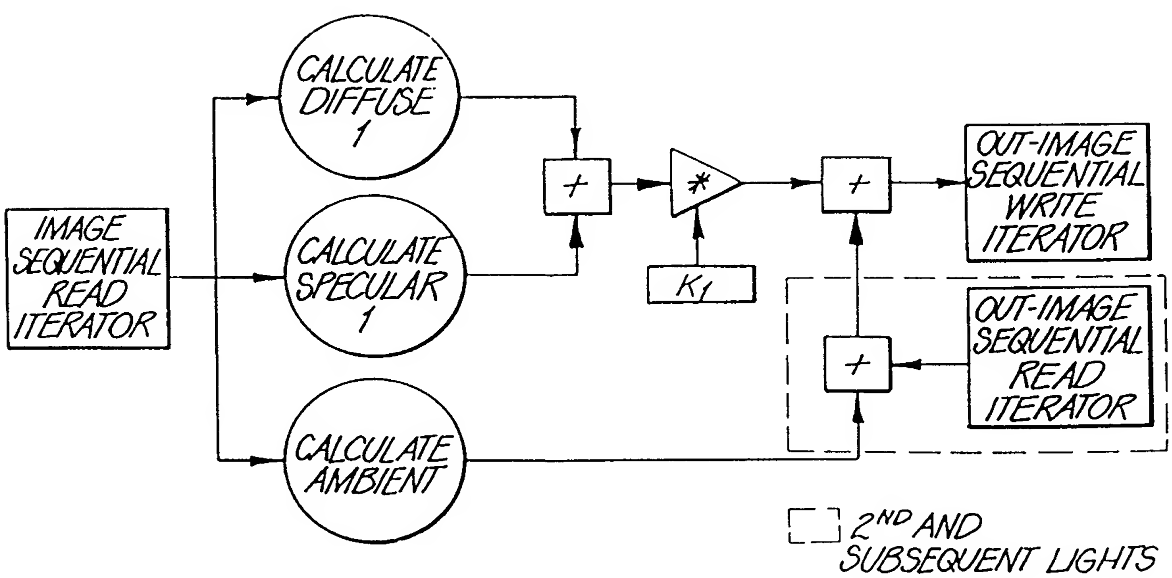
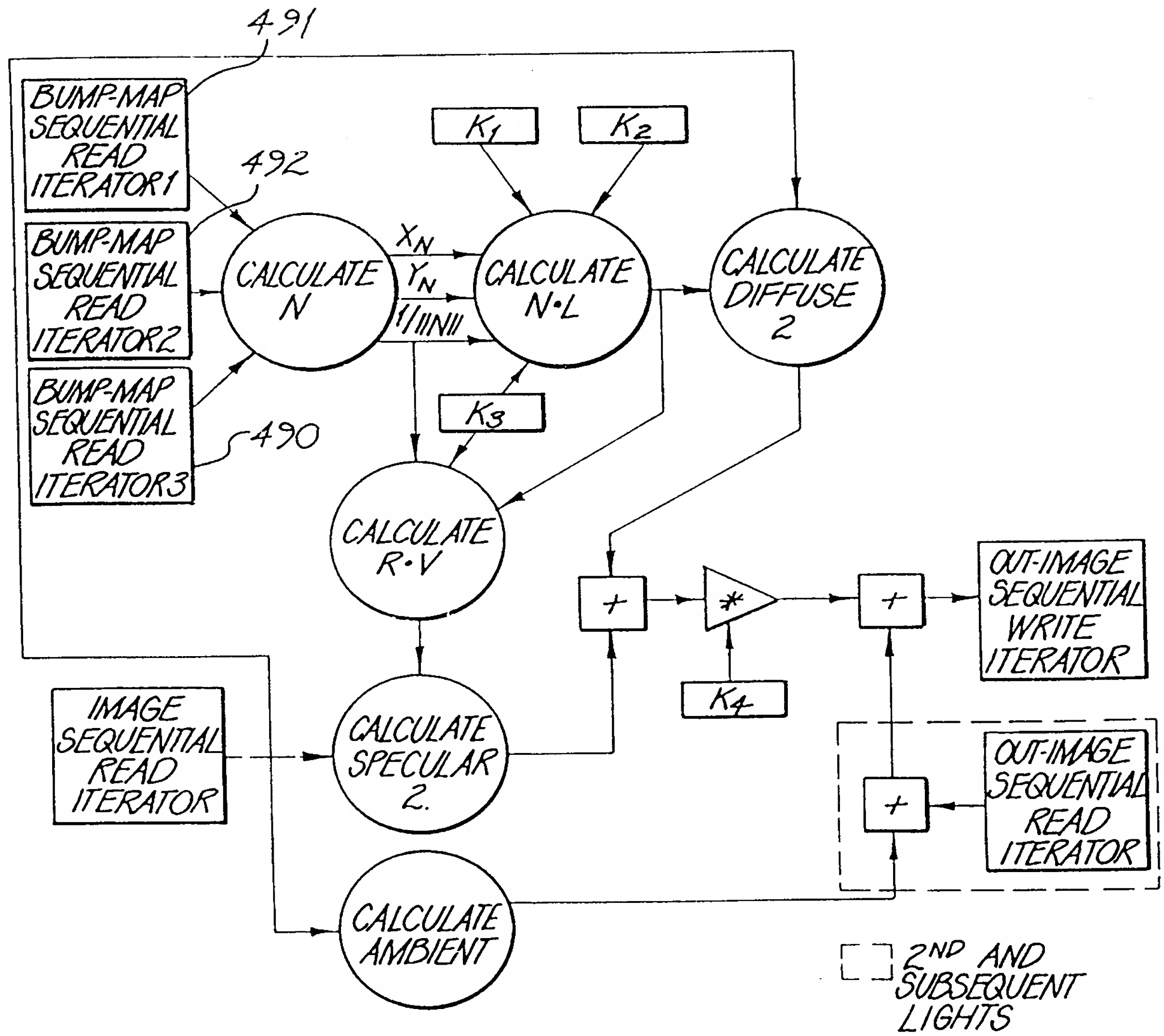


FIG. 147



491
BUMP-MAP SEQUENTIAL READ ITERATOR 1
492
BUMP-MAP SEQUENTIAL READ ITERATOR 2
BUMP-MAP SEQUENTIAL READ ITERATOR 3
490
CALCULATE N
X_N
Y_N
1/‖N‖
K_1
K_2
CALCULATE N•L
CALCULATE DIFFUSE 2
K_3
CALCULATE R•V
+
*
+
K_4
OUT-IMAGE SEQUENTIAL WRITE ITERATOR
IMAGE SEQUENTIAL READ ITERATOR
CALCULATE SPECULAR 2.
+
OUT-IMAGE SEQUENTIAL READ ITERATOR
CALCULATE AMBIENT
2ND AND SUBSEQUENT LIGHTS

FIG. 148

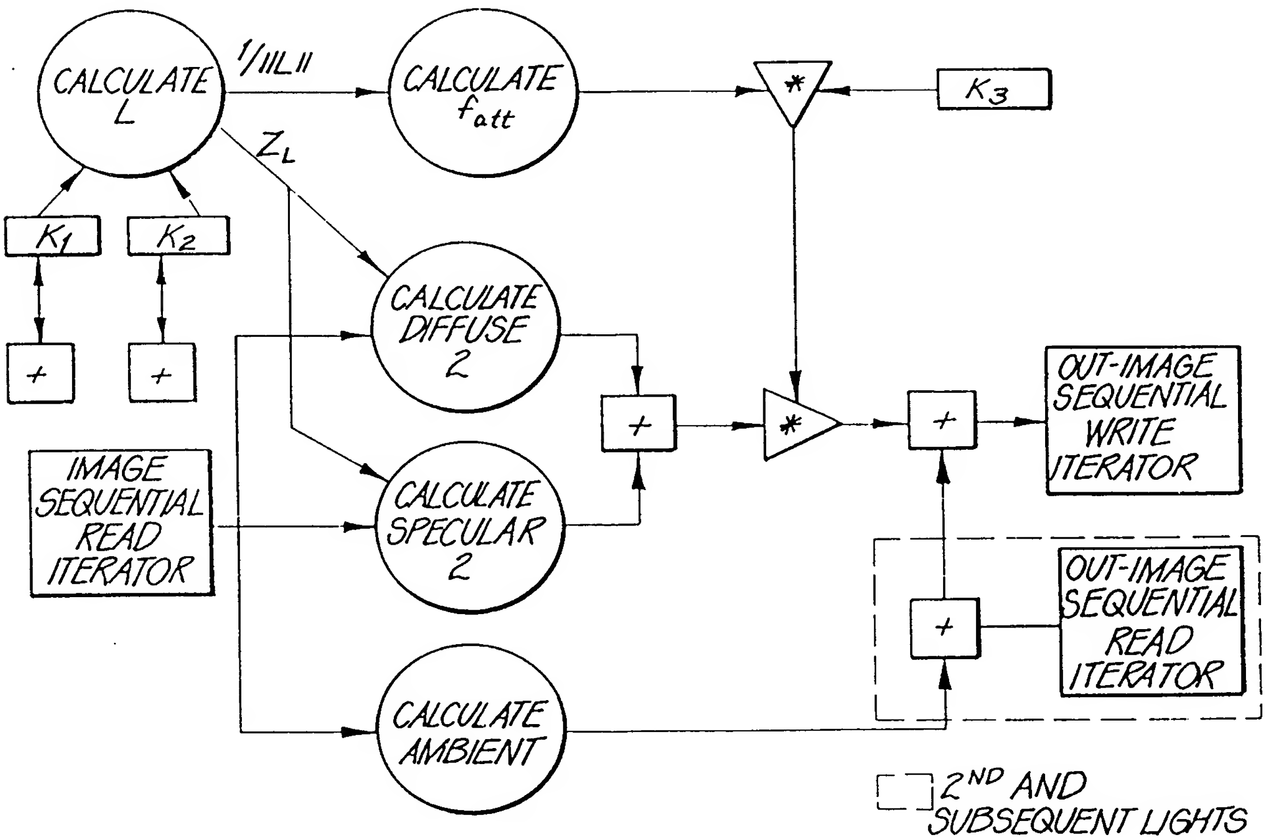

CALCULATE L
1/IILII
CALCULATE f_{att}
Z_L
K_1
K_2
K_3
+
+
*
CALCULATE DIFFUSE 2
IMAGE SEQUENTIAL READ ITERATOR
CALCULATE SPECULAR 2
+
*
+
OUT-IMAGE SEQUENTIAL WRITE ITERATOR
+
OUT-IMAGE SEQUENTIAL READ ITERATOR
CALCULATE AMBIENT
2ND AND SUBSEQUENT LIGHTS

FIG. 149

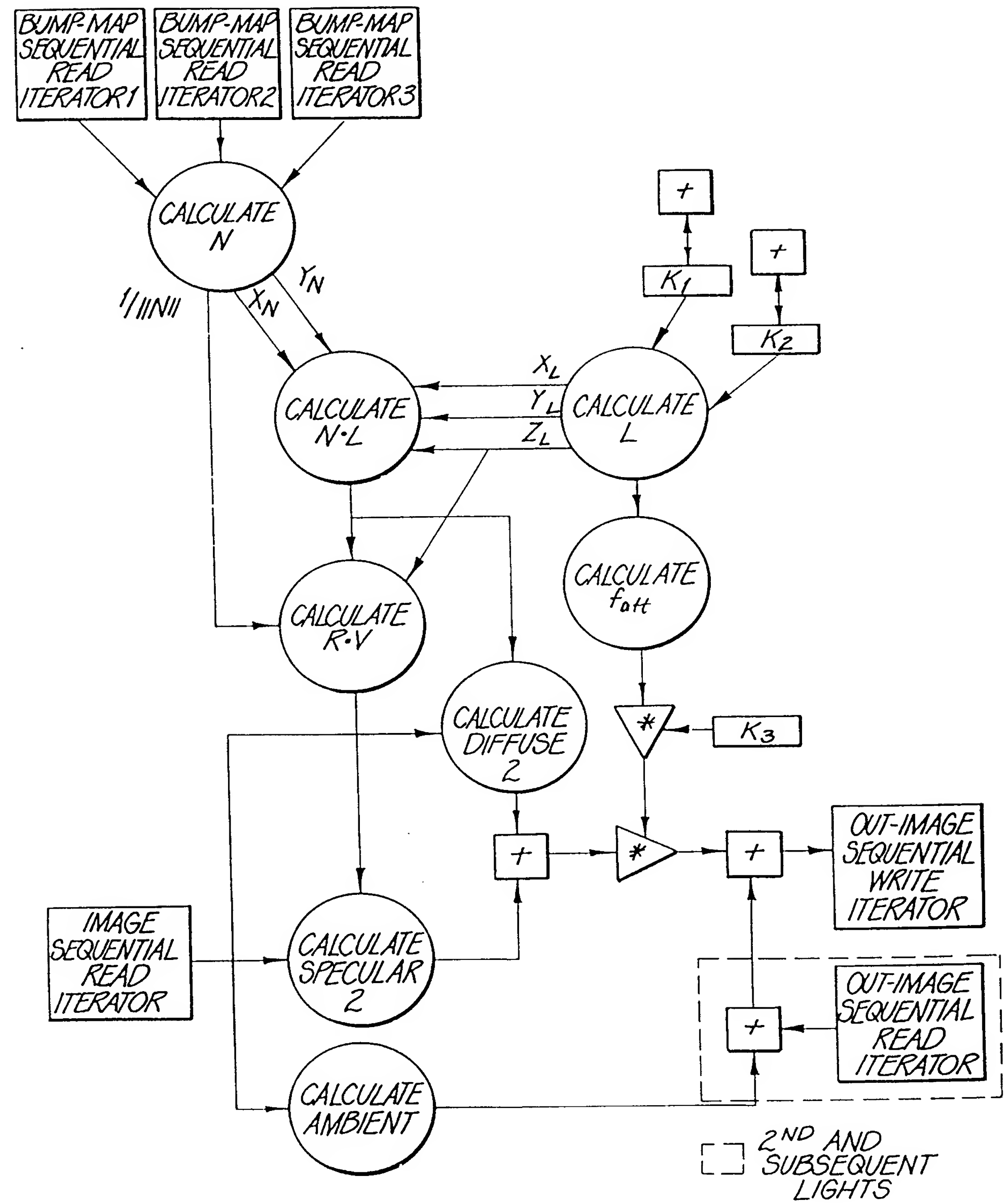

BUMP-MAP SEQUENTIAL READ ITERATOR 1
BUMP-MAP SEQUENTIAL READ ITERATOR 2
BUMP-MAP SEQUENTIAL READ ITERATOR 3
CALCULATE N
1/||N||
X_N
Y_N
+
+
K_1
K_2
CALCULATE N·L
X_L
Y_L
Z_L
CALCULATE L
CALCULATE R·V
CALCULATE f_{att}
CALCULATE DIFFUSE 2
*
K_3
+
*
+
OUT-IMAGE SEQUENTIAL WRITE ITERATOR
IMAGE SEQUENTIAL READ ITERATOR
CALCULATE SPECULAR 2
+
OUT-IMAGE SEQUENTIAL READ ITERATOR
CALCULATE AMBIENT
2ND AND SUBSEQUENT LIGHTS

FIG. 150

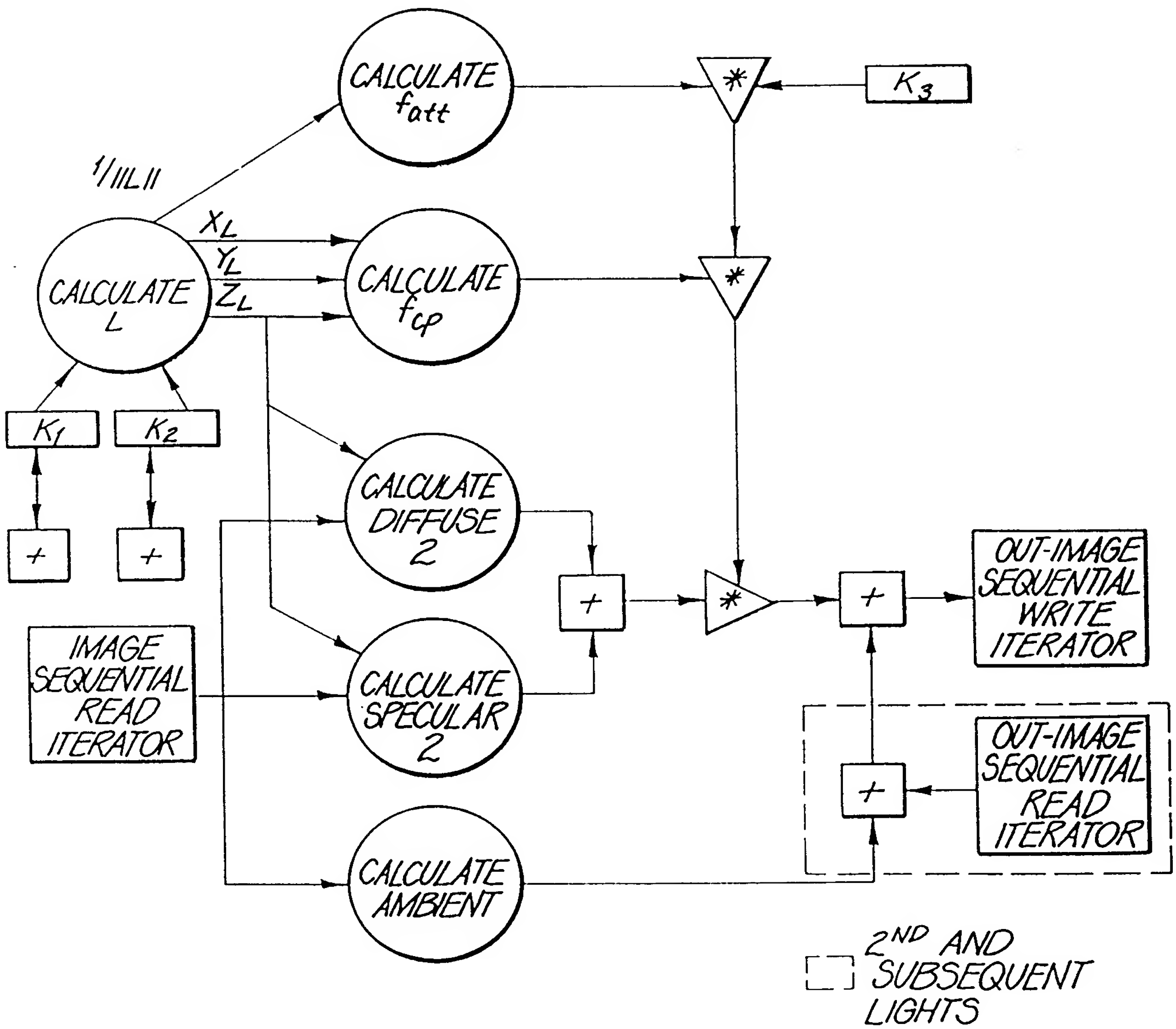

CALCULATE fatt
K3
1/IILII
XL
YL
ZL
CALCULATE L
CALCULATE fcp
K1
K2
+
+
CALCULATE DIFFUSE 2
+
IMAGE SEQUENTIAL READ ITERATOR
CALCULATE SPECULAR 2
OUT-IMAGE SEQUENTIAL WRITE ITERATOR
OUT-IMAGE SEQUENTIAL READ ITERATOR
CALCULATE AMBIENT
2ND AND SUBSEQUENT LIGHTS

FIG. 151

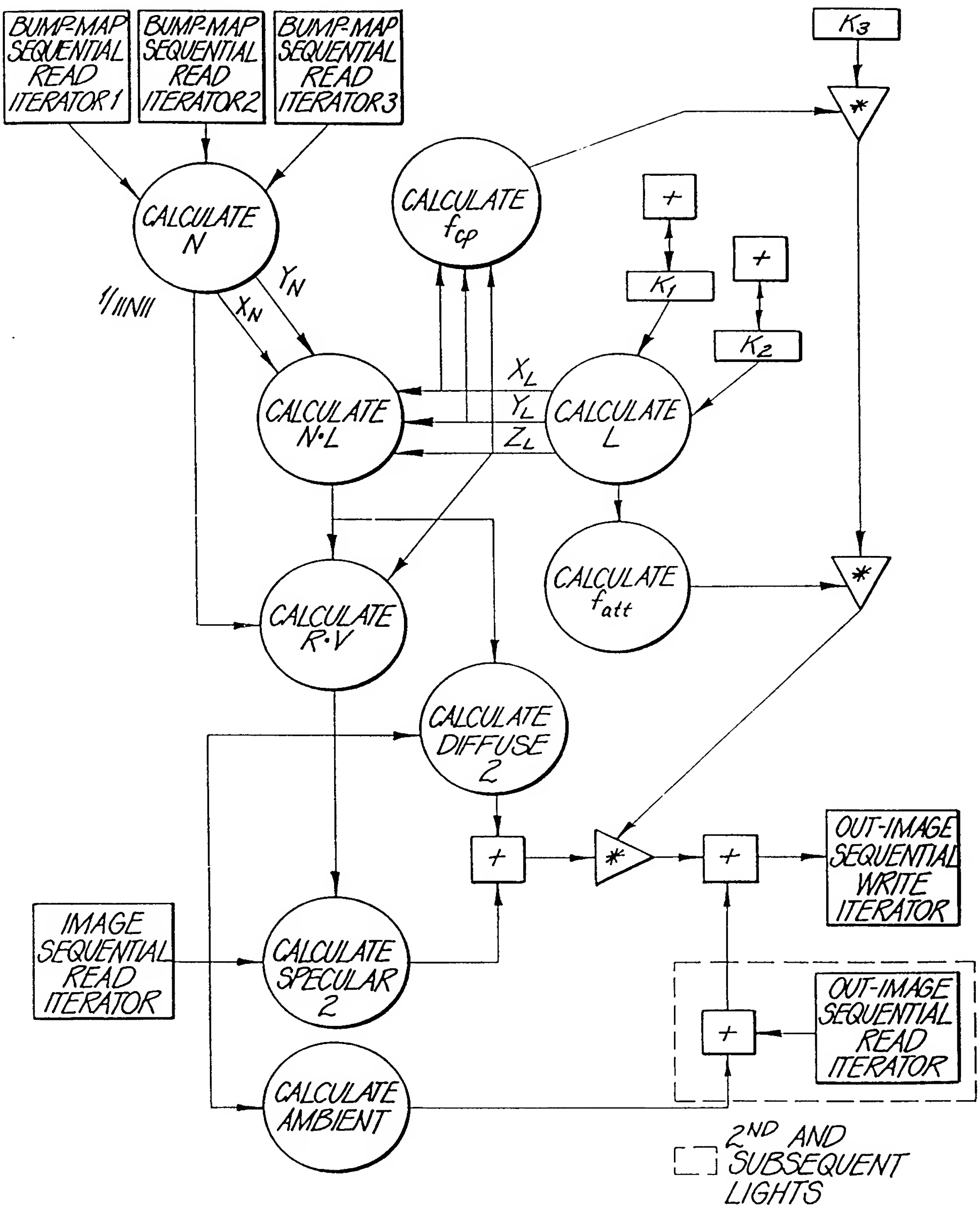
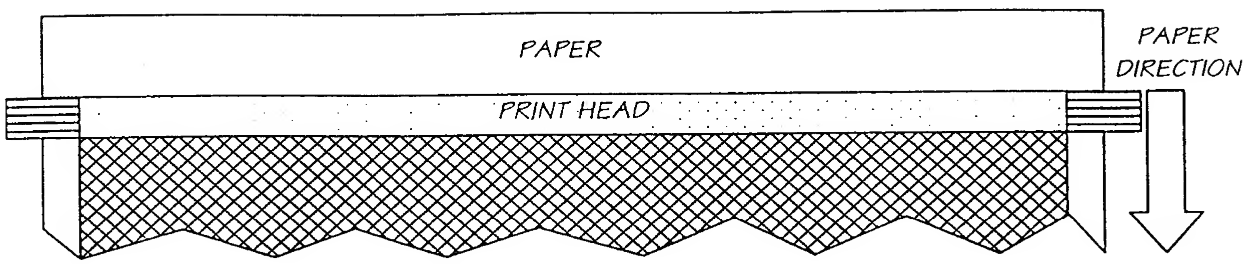
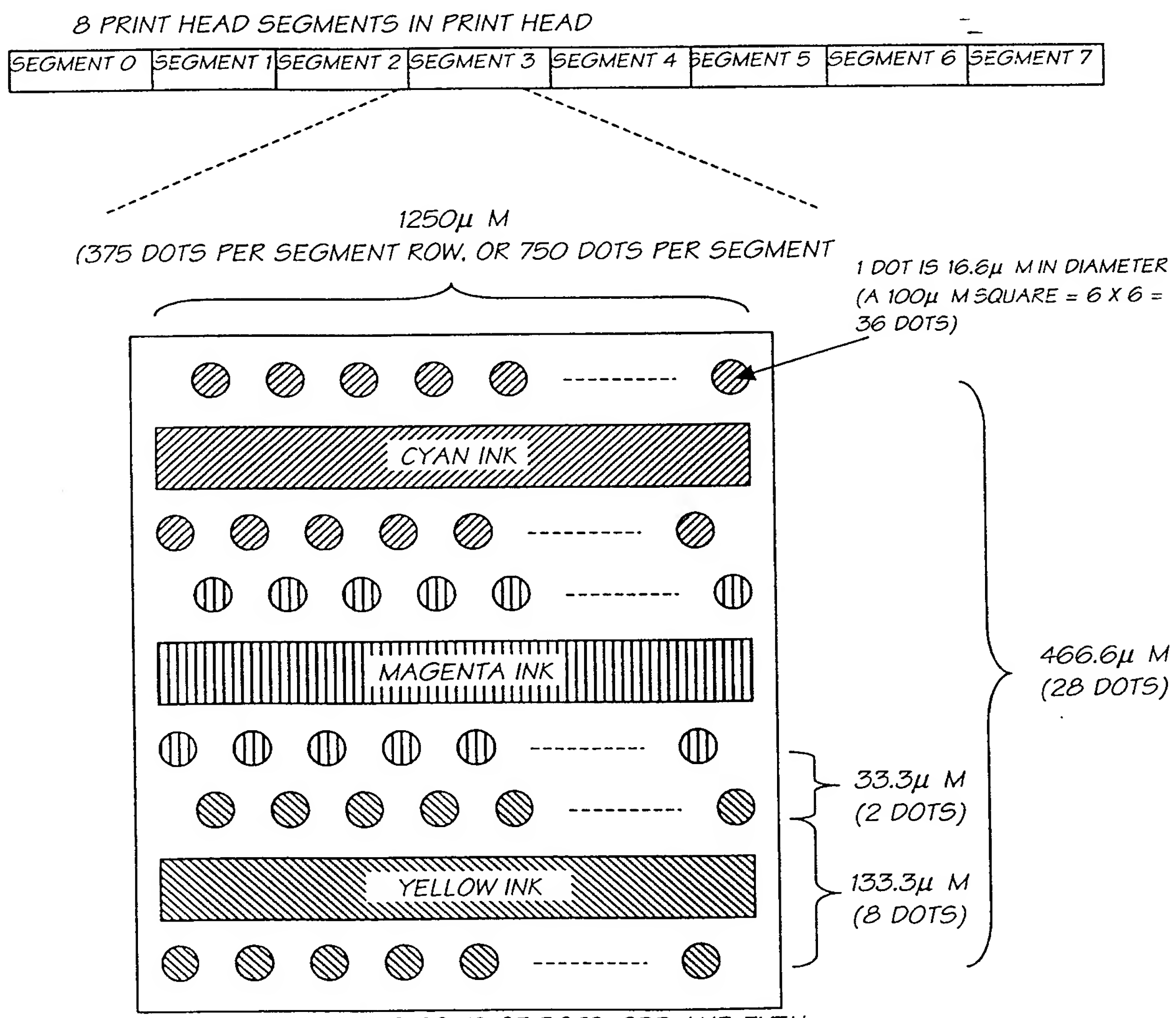

BUMP-MAP SEQUENTIAL READ ITERATOR 1
BUMP-MAP SEQUENTIAL READ ITERATOR 2
BUMP-MAP SEQUENTIAL READ ITERATOR 3
K3
*
CALCULATE N
CALCULATE fcp
+
+
K1
K2
YN
XN
1/||N||
XL
YL
ZL
CALCULATE N•L
CALCULATE L
CALCULATE R•V
CALCULATE fatt
*
CALCULATE DIFFUSE 2
+
*
+
OUT-IMAGE SEQUENTIAL WRITE ITERATOR
IMAGE SEQUENTIAL READ ITERATOR
CALCULATE SPECULAR 2
+
OUT-IMAGE SEQUENTIAL READ ITERATOR
CALCULATE AMBIENT
2ND AND SUBSEQUENT LIGHTS

FIG. 152


PAPER
PAPER DIRECTION
PRINT HEAD


8 PRINT HEAD SEGMENTS IN PRINT HEAD
SEGMENT 0
SEGMENT 1
SEGMENT 2
SEGMENT 3
SEGMENT 4
SEGMENT 5
SEGMENT 6
SEGMENT 7
1250μ M
(375 DOTS PER SEGMENT ROW, OR 750 DOTS PER SEGMENT
1 DOT IS 16.6μ M IN DIAMETER
(A 100μ M SQUARE = 6 X 6 =
36 DOTS)
CYAN INK
MAGENTA INK
YELLOW INK
466.6μ M
(28 DOTS)
33.3μ M
(2 DOTS)
133.3μ M
(8 DOTS)

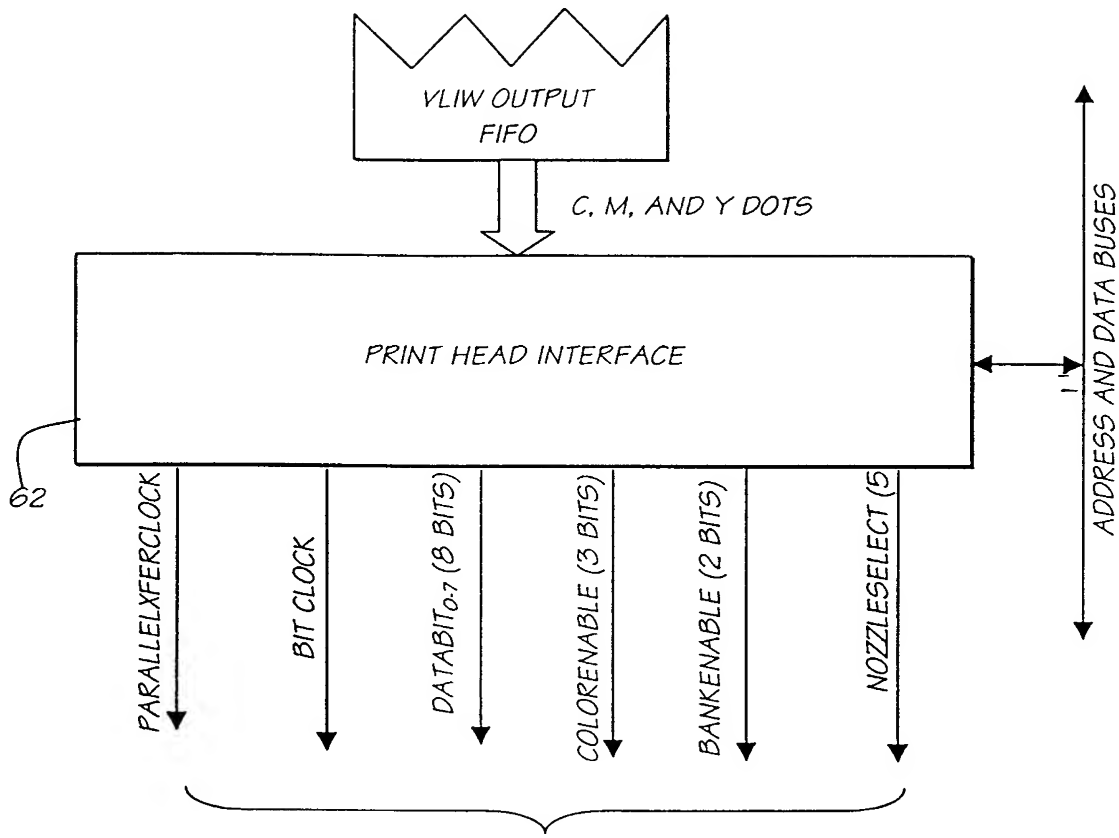


FIG. 154

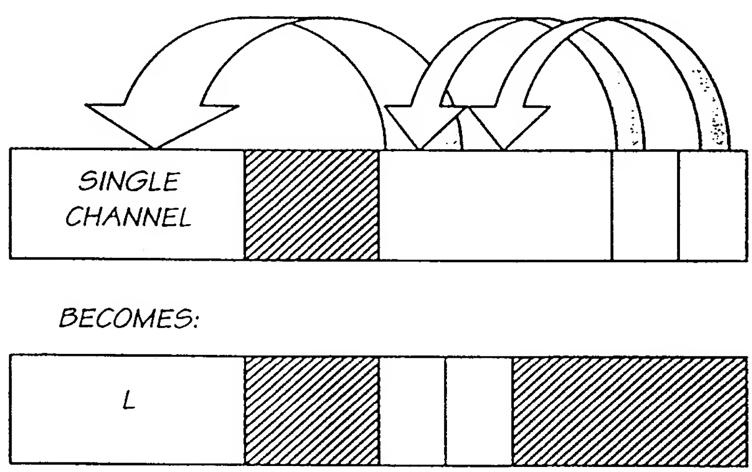


FIG. 155

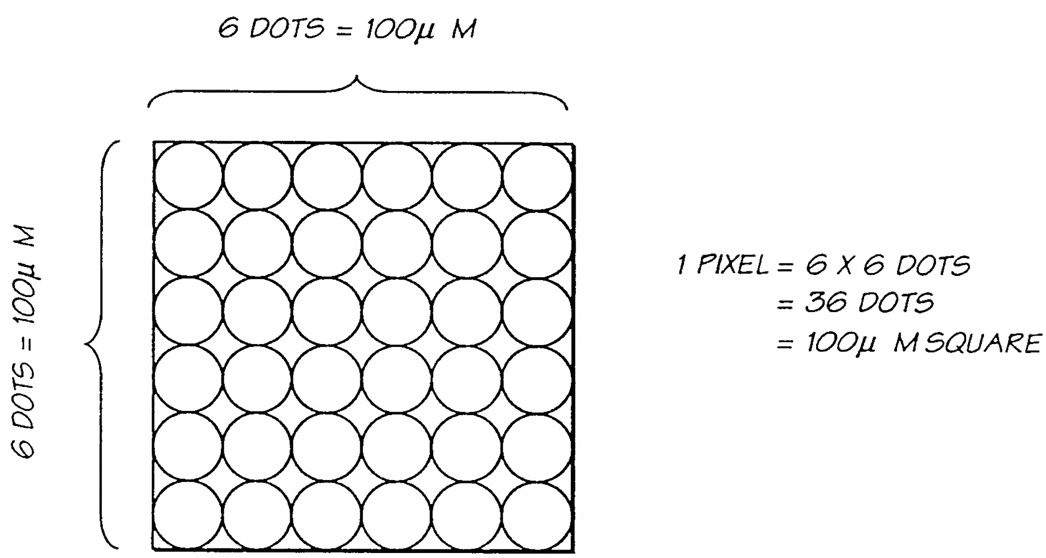

6 DOTS = 100μ M
6 DOTS = 100μ M
1 PIXEL = 6 X 6 DOTS
= 36 DOTS
= 100μ M SQUARE

FIG. 156

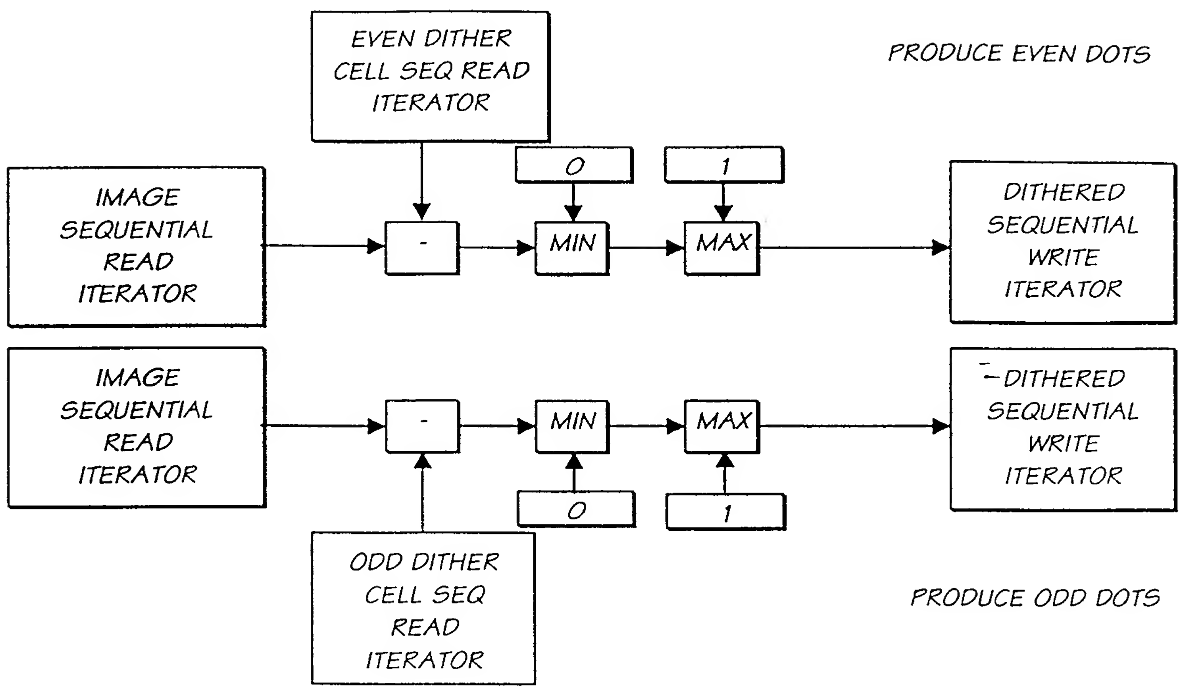
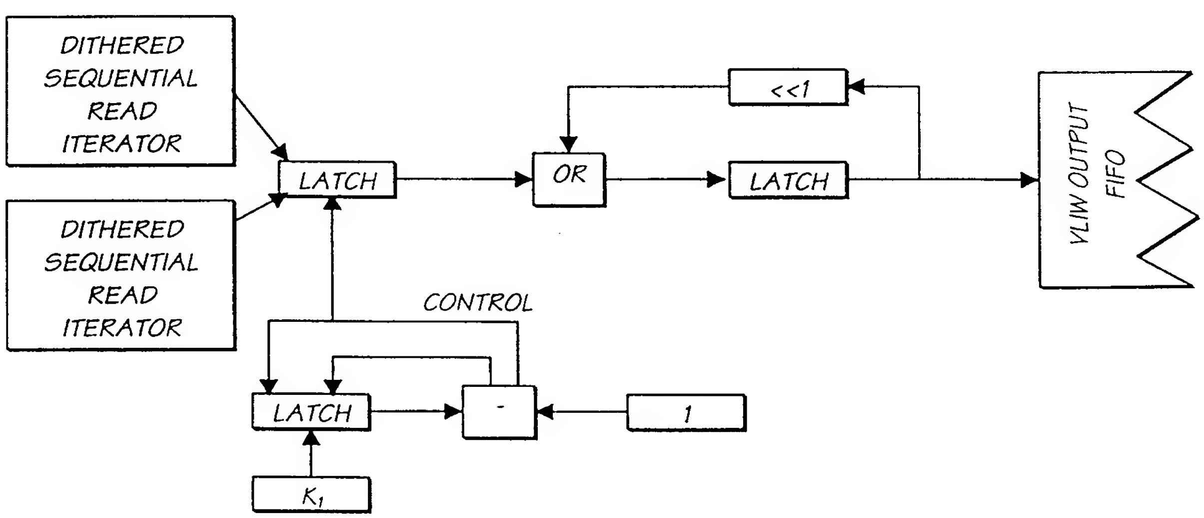

EVEN DITHER CELL SEQ READ ITERATOR
PRODUCE EVEN DOTS
IMAGE SEQUENTIAL READ ITERATOR
-
0
MIN
1
MAX
DITHERED SEQUENTIAL WRITE ITERATOR
IMAGE SEQUENTIAL READ ITERATOR
-
MIN
MAX
DITHERED SEQUENTIAL WRITE ITERATOR
0
1
ODD DITHER CELL SEQ READ ITERATOR
PRODUCE ODD DOTS

FIG. 157


DITHERED SEQUENTIAL READ ITERATOR
DITHERED SEQUENTIAL READ ITERATOR
LATCH
OR
<<1
LATCH
VLIW OUTPUT FIFO
CONTROL
LATCH
-
1
K1

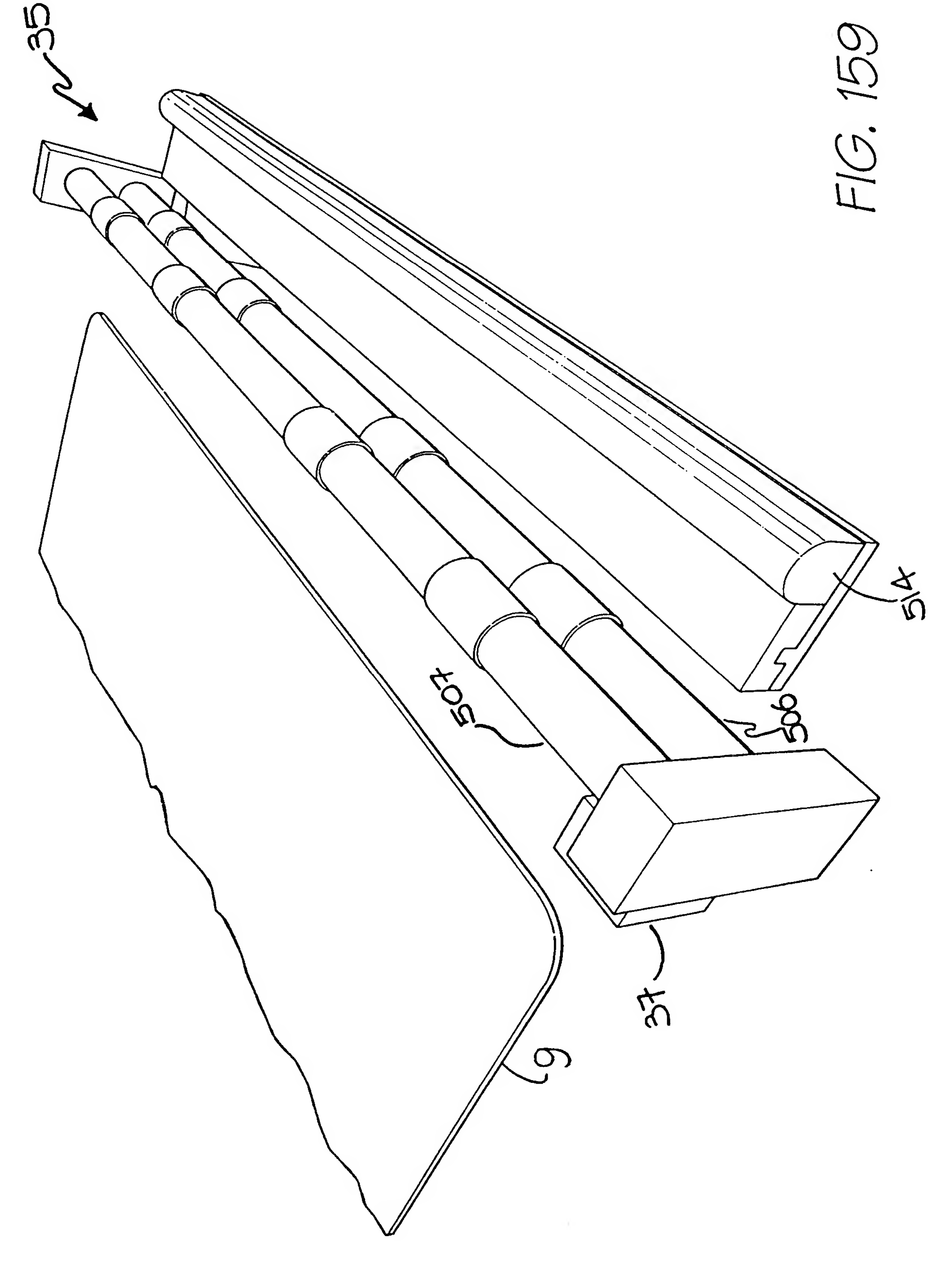


FIG. 159

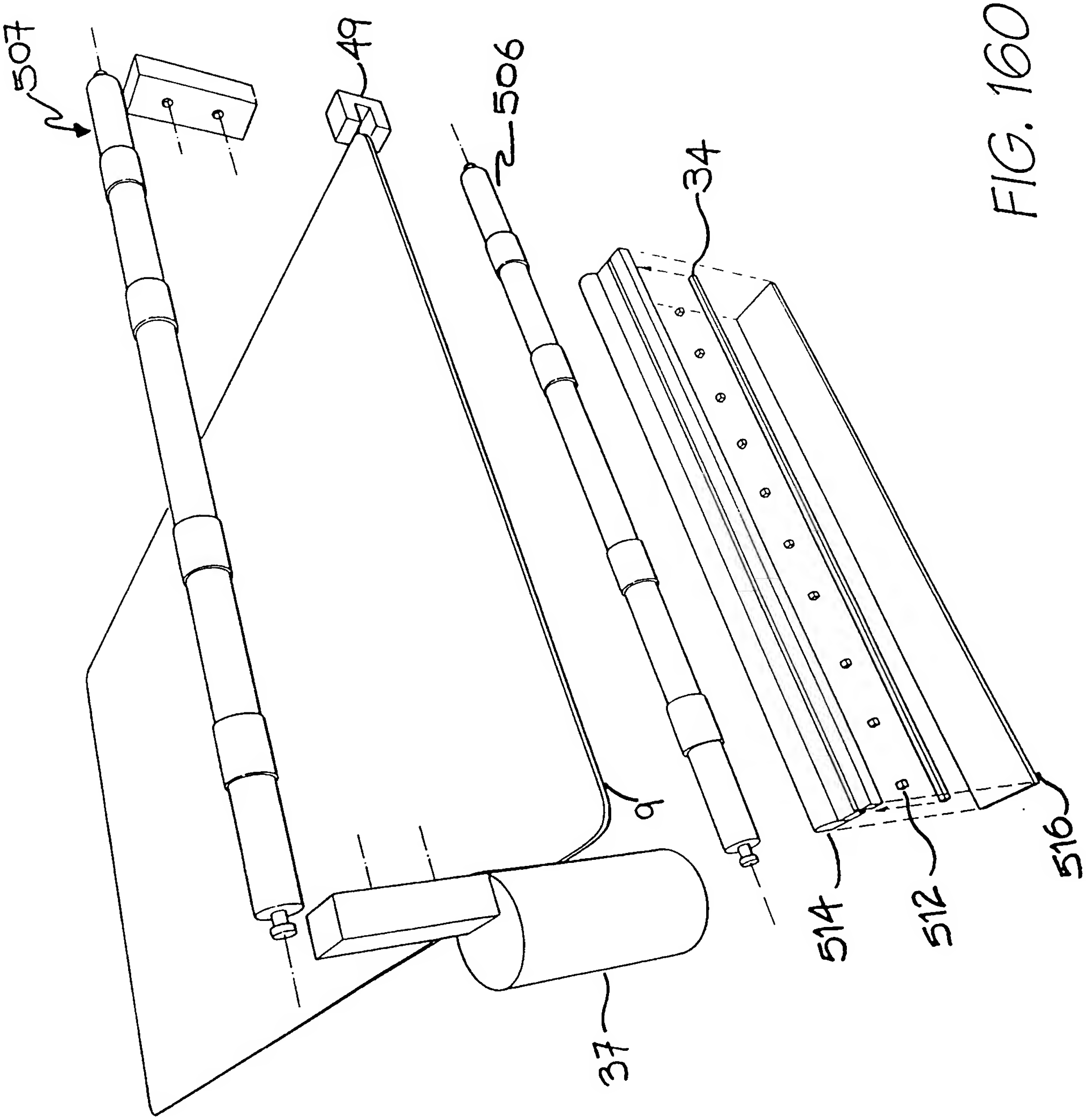


FIG. 160

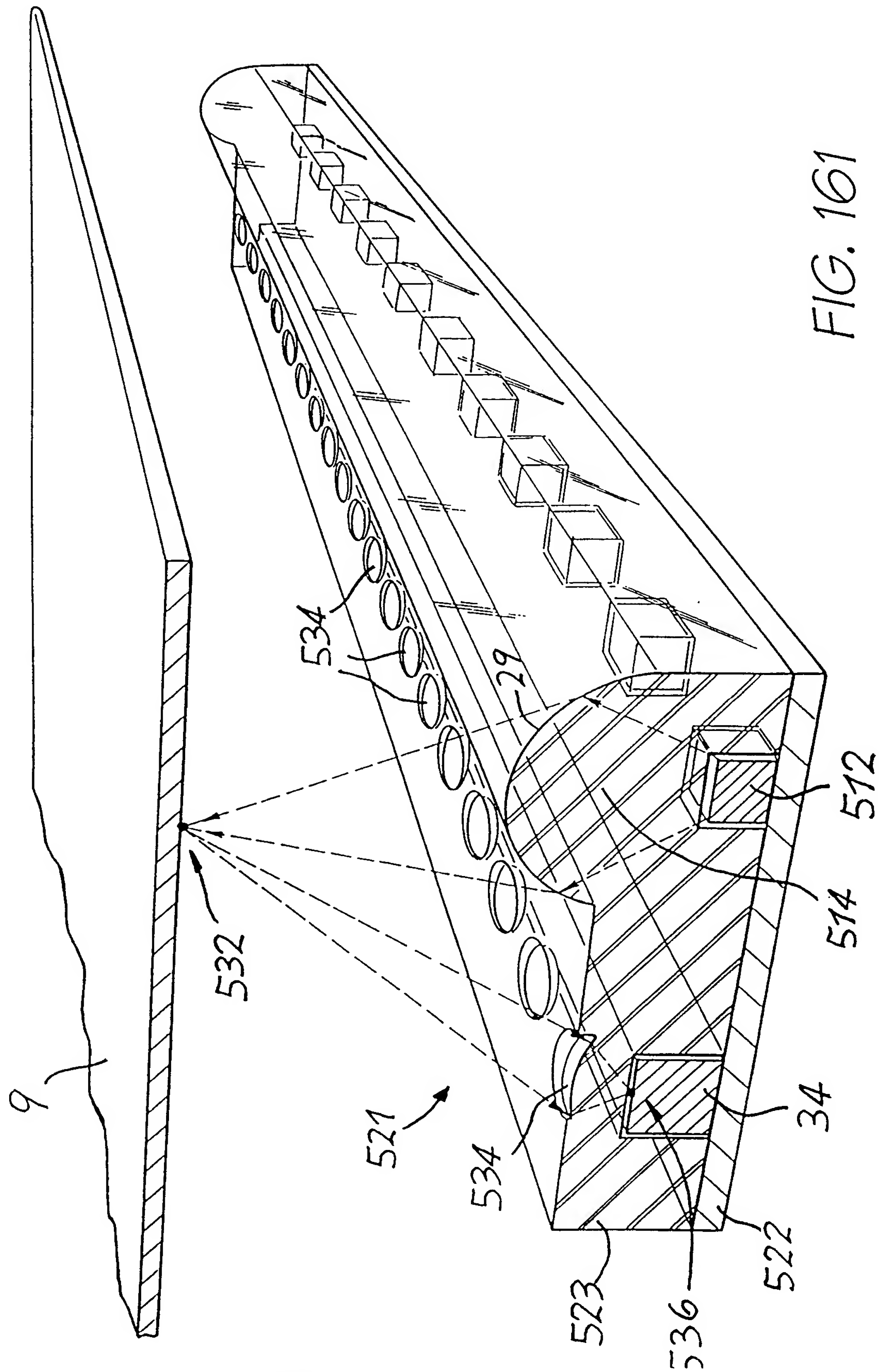


FIG. 161

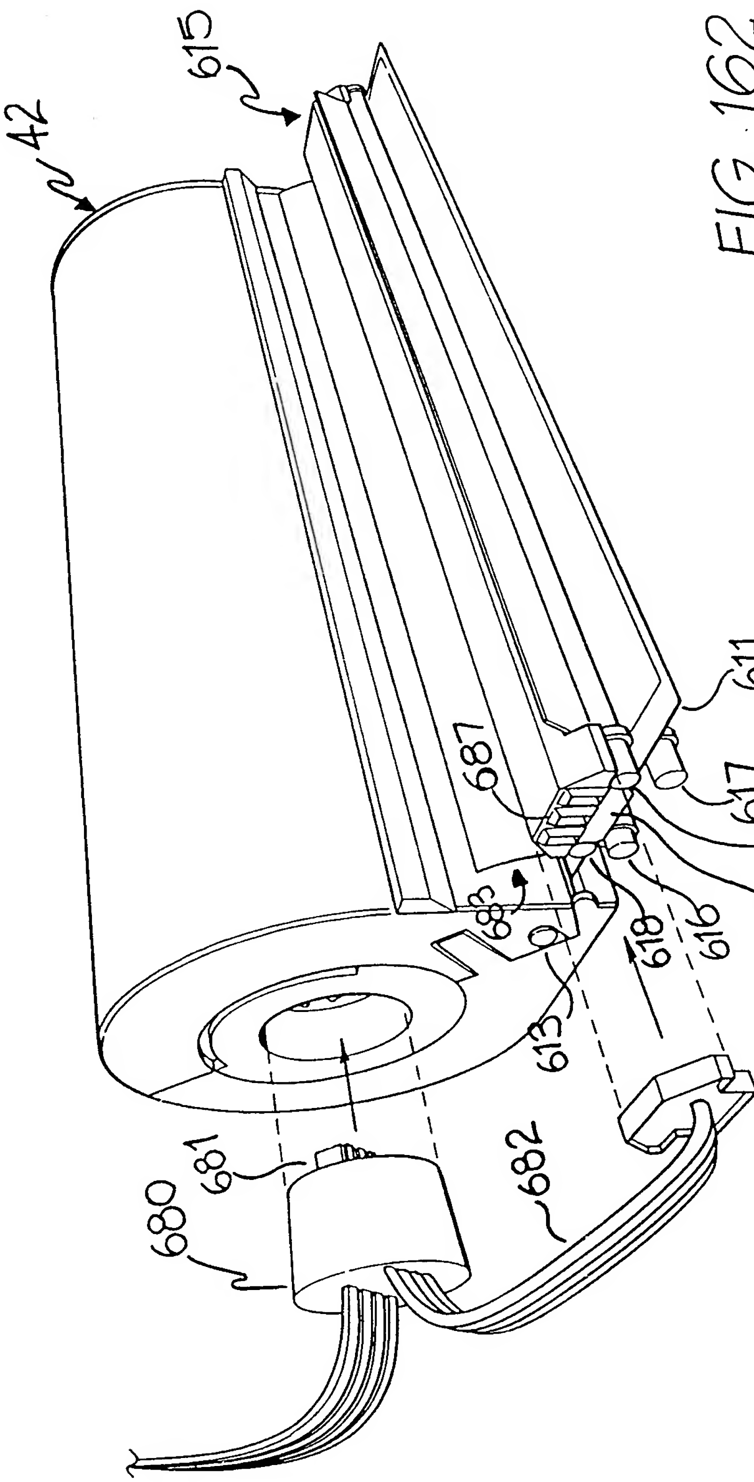


FIG. 162

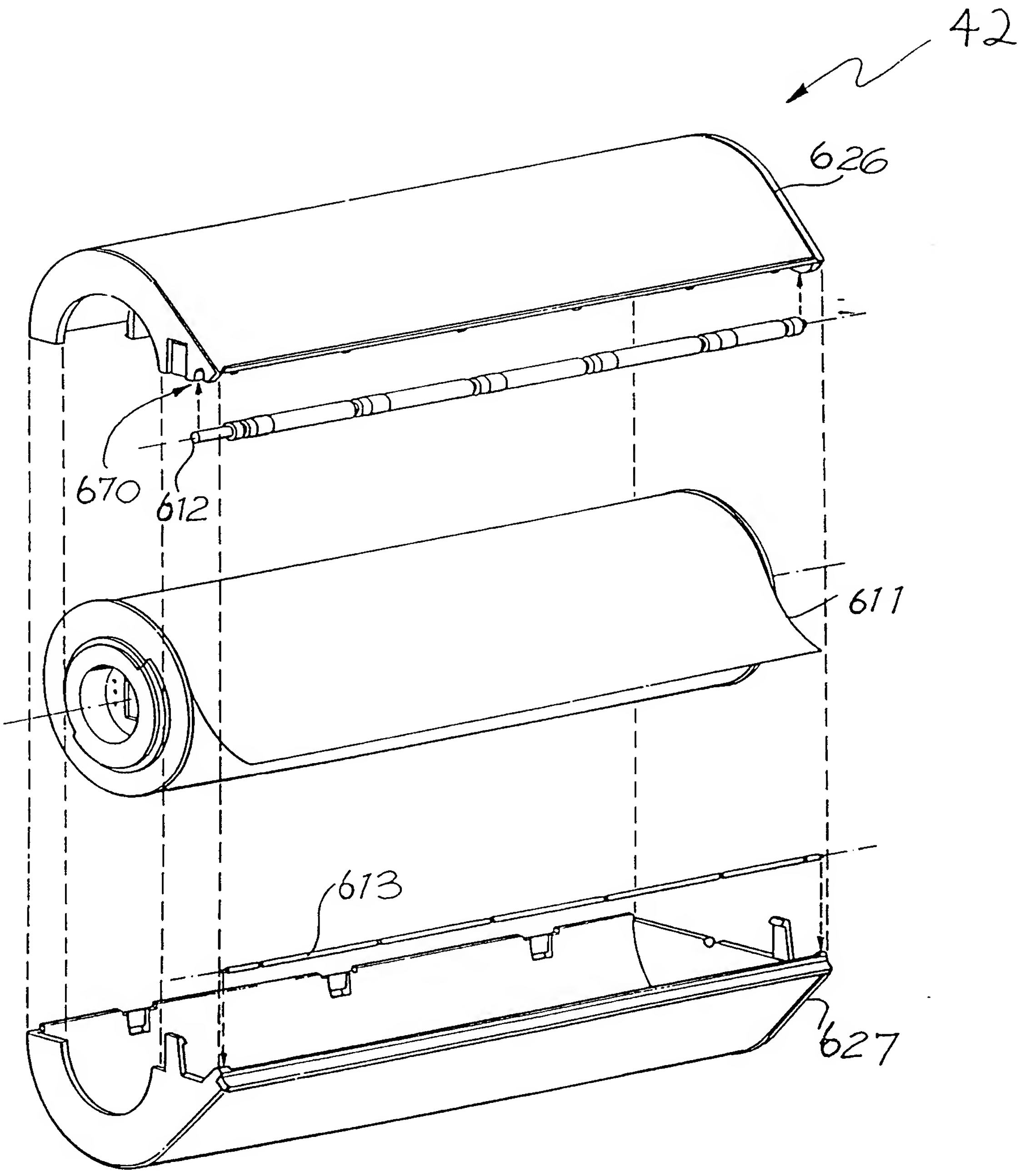


FIG. 163

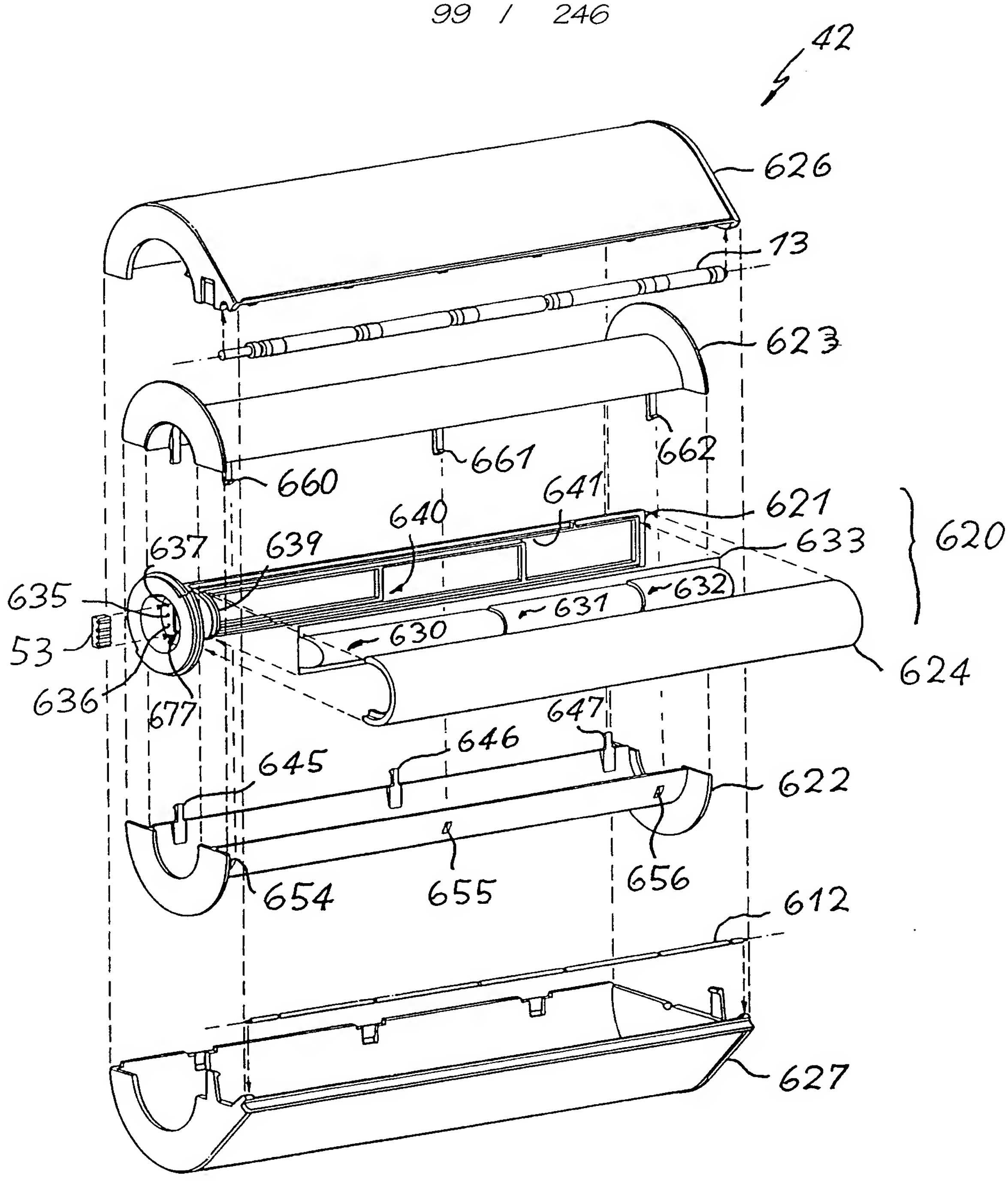

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FIG. 164

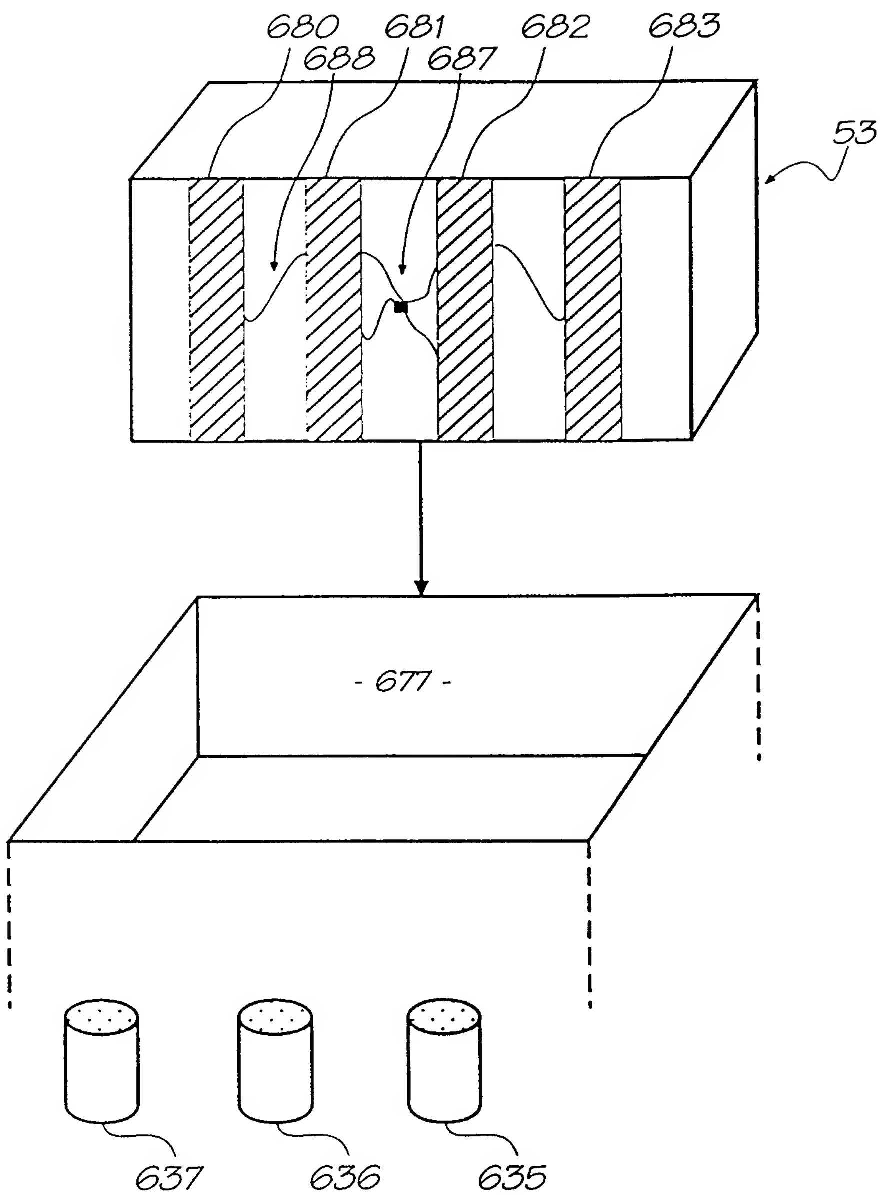

FIG. 165

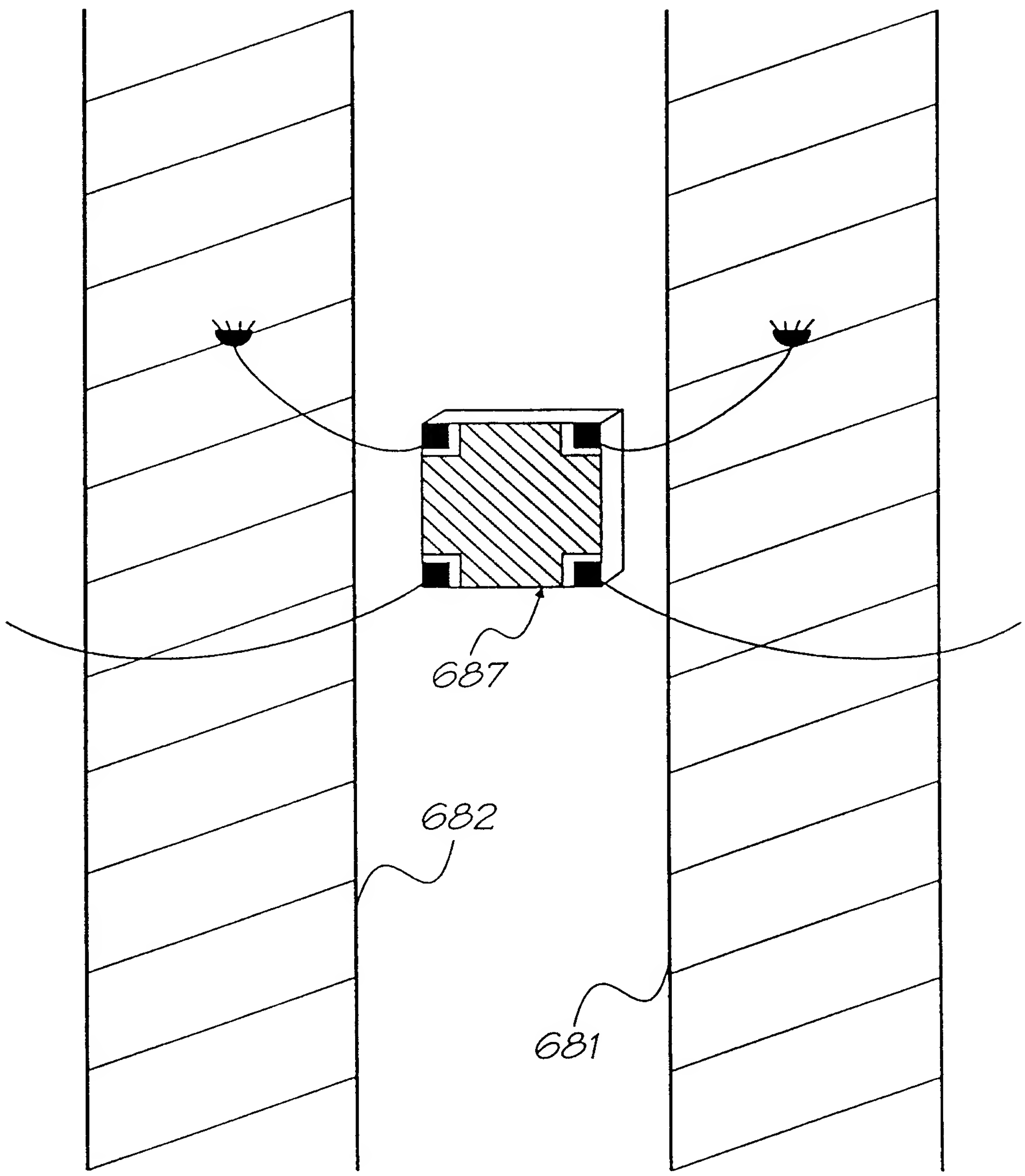

FIG. 166

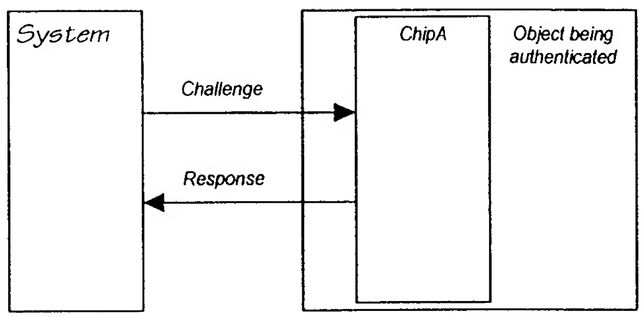

FIG. 167

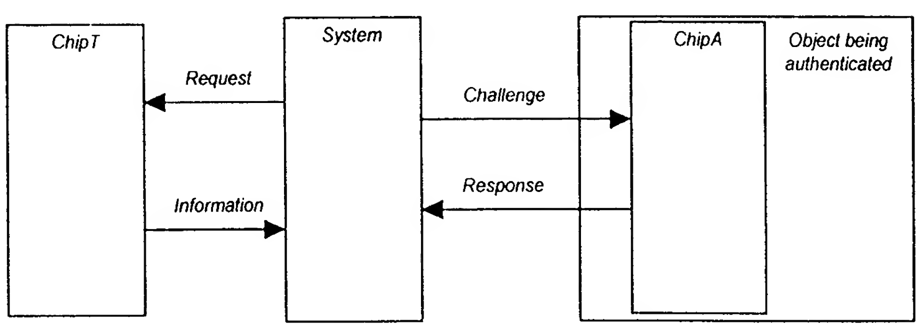

FIG. 168

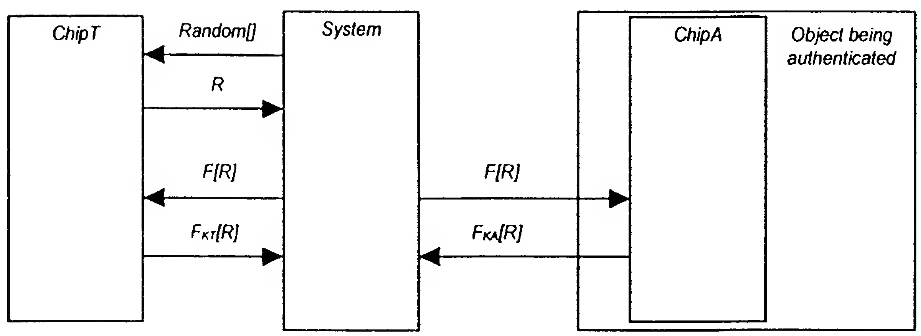

FIG. 169

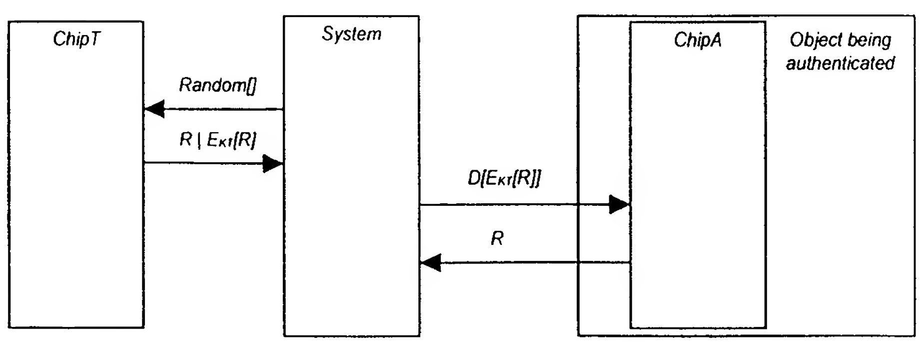

FIG. 170